INSTRUCTION MANUAL

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MODEL 700/703

SIGNAL CONDITIONING MODULE

DANA®

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INSTRUCTION MANUAL

MODEL 700/703

SIGNAL CONDITIONING MODULE

This manual is to be used in conjunction with either the 5330/5370 or the 5333 Digital Multimeter manual.

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DANA®

TELEPHONE (714) 833-1234
TELETYPE 910-595-1136
TELEX 678-341

January 1971
Revised April 1973

Bottom plate of signal conditioning module 700

DC CALIBRATION PROCEDURE

(ALLOW ONE-HALF HOUR FOR WARM-UP)

READOUT BOARD

1. ADJUST "ZERO OFFSET" (ON FRONT PANEL) WITH INPUT SHORTED ON THE .1-DC RANGE.
2. ADJUST R63 (INTEGRATOR ZERO) FOR +, −, BOUNCING POLARITY. 10-DC RANGE.
3. APPLY 1mV INPUT SIGNAL AND ADJUST R65 FOR A DISPLAY OF 10 DIGITS — VERIFY READING OF + or − 10 DIGITS AS INPUT IS REVERSED. REPEAT 2 & 3 IF NECESSARY.
4. APPLY −9.99995V AND ADJUST R76 FOR −9.9999 BOUNCING TO −10.0000.
5. APPLY +9.99995V AND ADJUST R80 FOR +9.9999 BOUNCING TO +10.0000.

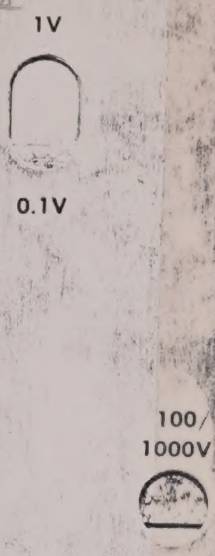
MODULE ZERO (PLACE IN DC-AUTO)

1. WITH A ONE MEGOHM RESISTOR ACROSS INPUT, ADJUST "CURRENT ZERO" FOR ZERO INDICATION ON READOUT.
2. WITH INPUT SHORTED ADJUST "ZERO OFFSET" FOR ZERO. REPEAT 1 & 2 IF NECESSARY.

RANGE CALIBRATION (PLACE IN DC-AUTO)

1. APPLY 0.0999995V AND ADJUST "0.1" CAL POT FOR .099999 BOUNCING TO .100000.
2. APPLY 0.999995V AND ADJUST "1.0" CAL POT FOR 0.99999 BOUNCING TO 1.00000.
3. APPLY 99.9995V AND ADJUST "100/1000V" CAL POT FOR 099.999 BOUNCING TO 100.000.

TO CALIBRATE ACCESSORIES SEE MODULE TOP COVER



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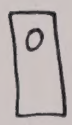

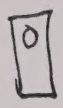

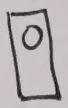

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SECTION 1

INTRODUCTION

1.1 SCOPE.

1.2 This manual covers Signal Conditioning Modules 700 and 703. Model 700 can be used with Model 5330, 5370 or 5333 Digital Multimeters (mainframe assemblies). Model 703 is equipped for isolated programming and is used only with the Model 5333 Multimeter.

1.3 Descriptions in this manual of the "Signal Conditioning Module" pertain to both Model 700 and Model 703 except where indicated. Descriptions of the digital and readout sections are included in the appropriate Digital Multimeter manual (5330/5370 or 5333).

1.4 MECHANICAL DESCRIPTION.

1.5 The Signal Conditioning Module comprises the right-hand side of the 5330 and 5333 Multimeters and the lower half of Model 5370. It includes circuits that convert the input to a ten-volt full-scale analog voltage (plus 20% overrange) for measurement by the digital circuits in the multimeter.

1.6 Both models measure d-c voltages on five ranges, from ±.1 to 1000V (plus overrange). Optional accessories enable the measurement of AC, Ohms, or both. Accessory model numbers are listed below:

Model 51 AC Converter
Model 61 Ohms Converter
Model 71 AC/Ohms Converter

Model 51 provides AC measurements on four ranges, from 1V to 1000V rms. Model 61 provides Ohms measurements on six ranges, from .1 Kilohms to 10,000 Kilohms. Model 71 combines the capability of the other two accessories.

Figure 1.1 - Model 5333/703 Digital Multimeter

1.7 ELECTRICAL DESCRIPTION.

1.8 A block diagram of the Signal Conditioning Module is shown in figure 1.2. For DC measurements, the input is applied to a voltage divider that divides the input voltage by 1 or by 100 depending on the full-scale range. The scaled input is applied to the Isolator amplifier which delivers ten volts full-scale to the digitizing circuits in the multimeter mainframe assembly. The gain of the Isolator is 1, 10, or 100 depending on the range.

1.9 For AC measurements, the AC Converter scales the input and rectifies it. The converter output is applied through the voltage divider (set to 1:1) to the Isolator, set to a gain of 1.

1.10 For Ohms measurements, a known current is applied through the unknown resistance. The voltage drop is measured and treated as a conventional d-c voltage measurement. The result is displayed in kilohms.

1.11 Each module is equipped with autorange circuits that switch to the optimum range automatically in AC, DC, and Ohms measurement modes.

100mV range 6 mos.

+ 0.005% of range = 5μV

Input

1μV = 0
10 mV = 4 μV
50 mV = 4 μV
100 mV = 8 μV
~~500 mV = 40 μV~~
~~1 V =~~

1 V range 6 mo

+ 0.002% of range = 20μV

Input

500 mV = ~~400~~ 80 μV
1 V = 80 μV

10 V range

+ 0.002% of range = 200μV

Input

2V = 160 μV
5V = 400 μV
10 V = 800 μV

100 V range

+ 0.002% of range = 2mV

Input

20 V = ~~160 μV~~ 1.6 mV
50 V = 4.0 mV
100 V = 8 mV

1000 V range

+ 0.002% of range = 20mV

200 V = 16 mV
500 V = 40 mV
1000 V = 80 mV

OHMS

1K

0.002% of range = 0.02

1K = 0.1Ω
5K = 0.5Ω

10 KΩ

.002% of range = 0.2Ω
10 K = 1Ω
50 K = 5Ω

100 KΩ

.002% of range = 2Ω
100K = 10Ω
500K = 50Ω

~~1 MΩ~~

1000 KΩ

0.002% of range = 20Ω
1 MΩ = 150
5 MΩ = 750

10 000 KΩ

0.002% of range = 200Ω

10 MΩ = 3 KΩ

Table 1.1 - Specifications

DC

Full Range Display:	±.100000, ±1.00000, ±10.0000, ±100.000, ±1000.00
Overrange:	20% on all ranges, ±1000 volts maximum input
Resolution:	1 microvolt
Accuracy:*	24 hours, 25°C, ±1°C 100 mV range ±(0.005% of reading +0.005% of range) IV–1000V range ±(0.005% of reading +0.001% of range) 6 months, 25°C, ±5°C 100 mV range ±(0.008% of reading +0.005% of range) 5μV IV–1000V range ±(0.008% of reading +0.002% of range)
Temperature Coefficient:	0 to 50°C 100 mV range ±(0.001% of reading +0.001% of range)°C IV–1000V range ±(0.001% of reading +0.0003% of range)°C
Input Resistance:	100 mV range 1,000 megohms IV range 10,000 megohms min. 10V range 10,000 megohms min. 100 and 1000V ranges 10 megohms
Normal Mode Noise Rejection:	Filter in At or near line frequency 74 dB (5000 to 1) Filter out At or near line frequency 48 dB (250 to 1)
Common Mode Noise Rejection:	Up to 1 kilohm in either lead: DC and at line frequency 120 dB minimum
Settling Time to 0.01% of Full Scale Step Input:	Filter in 500 ms Filter out 25 ms

AC

Full Range Display:	1.00000, 10.0000, 100.000, 1000.00 V rms
Overrange:	20% on all ranges; Maximum Voltage Rating: 500 volts to 40 kHz, decreasing linearly to 80V rms at 250 kHz. Maximum input voltage x frequency should be less than 2×10^7 Volt-Hz above
Resolution:	10 microvolts
Accuracy:	6 months, 25°C, ±5°C 30 Hz to 50 Hz ±(0.20% of reading +0.02% of range) 50 Hz to 30 kHz ±(0.10% of reading +0.02% of range) 30 kHz to 100 kHz ±(0.15% of reading +0.02% of range) 100 kHz to 250 kHz ±(2.00% of reading +0.10% of range)
Input Resistance:	1 megohm
Shunt Capacitance:	With front input only 150 pF maximum With parallel rear input, 300 pF maximum
Common Mode Noise Rejection:	Up to 1000 ohms in either lead DC 120 dB At line frequency 80 dB
Settling Time to 0.1% of Full Scale Step Input:	500 ms

GENERAL

Ranging:	Automatic or manual
Digitizing Technique:	Dual Slope Integrator
Integration Time:	100 ms
Digitizing Time:	220 ms maximum
Maximum Common Mode Voltage:	250 volts
Maximum Power Requirements:	25 watts, line voltage ±10%; 50 to 400 Hz
Operating Temperature:	0 to 50°C
Warm Up:	½ hour
Dimensions: **Model 5330** **Model 5370**	 17 x 3½ x 14 inches or 43.2 x 8.9 x 35.6 cm. 8½ x 7 x 14 inches or 21.6 x 17.8 x 35.6 cm.
Weight (Approx):	15 pounds net, 20 pounds shipping
Guarantee:	12 months, faulty workmanship or component failure

DC/DC RATIO

Full Range Display:	±.100000:1, 1.00000:1, 10.0000:1, 100.000:1, and ±1000.00:1 (Readout is Ratio x 10)		
Overrange:	20% on all ranges, ±1000 volts maximum input		
Accuracy:	6 months, 25°C, +5°C .100000:1 range ±(0.008% r, +0.005% (10V/ref.) f.s.) .10000:1 to 100.000 ±(0.008% r, +0.002% (10V/Ref.) f.s.)		
Voltage Range:		Input Sig (Numerator) 0 to ±1000V	Reference Sig (Denominator) +2 to +12 V
Input Resistance:	.01:1 range .1:1 range 1:1 range 10:1 and 100:1 ranges	1,000 megohms 10,000 megohms 10,000 megohms 10 megohms	1 megohm 1 megohm 1 megohm 1 megohm
Normal Mode Noise Rejection, Common Mode Noise Rejection, and Settling Time:	Same as DC specifications		

KILOHMS

Full Range Display:	.100000, 1.00000, 10.0000, 100.000, 1000.00 and 10000.0 kilohms
Overrange:	20% on all ranges Fault Voltage: All ranges 60V
Resolution:	1 milliohm
Accuracy:	6 months, 25°C, ±5°C .1 kilohm range ±(0.02% of reading +0.005% of range) 1, 10, 100 kilohm ranges ±(0.01% of reading +0.002% of range) 1000 kilohm range ±(0.015% of reading +0.002% of range) 20Ω 10,000 kilohm range ±(0.03% of reading +0.002% of range)
Settling Time to 0.01% of Full Scale Step Input:	Filter in 500 ms Filter out 25 ms
Current Through Unknown:	Kilohm Range / Current .1 / 1 milliampere 1 / 1 milliampere 10 / 1 milliampere 100 / 100 microampere 1000 / 10 microamperes 10,000 / 1 microampere

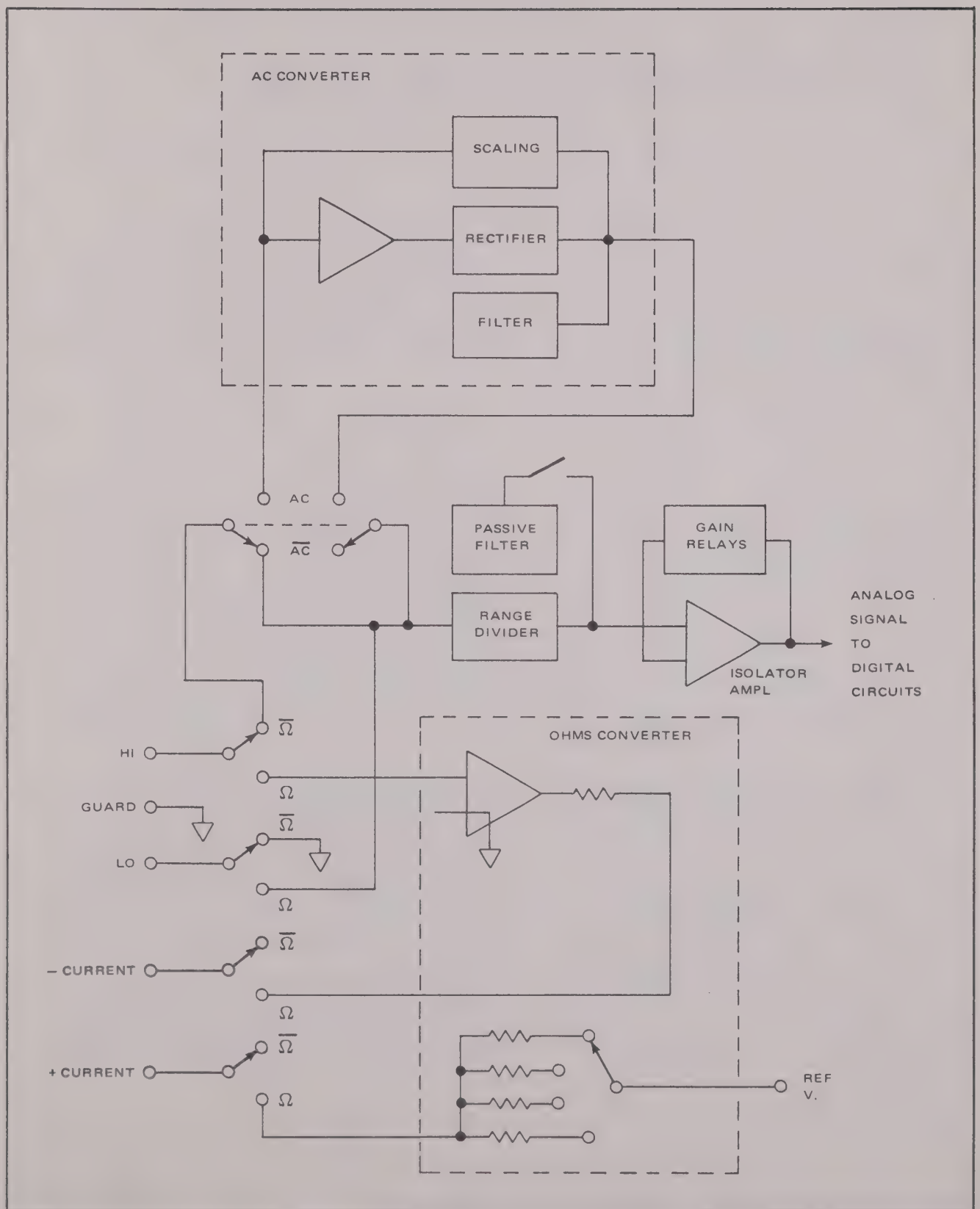


Figure 1.2 - Block Diagram

SECTION 2

INSTALLATION AND OPERATION

2.1 INPUT CONNECTIONS.

2.2 Signal input binding posts are located on the front of the accessory module. Connections to these terminals are made with standard "banana" plugs. Instruments designated by a "dash 1" (–1) following the model number are equipped with a duplicate set of input binding posts on the rear panel of the instrument.

2.3 INITIAL CHECKOUT PROCEDURES.

2.4 The shipping carton and its internal support structure have been scientifically designed for maximum protection of the instrument. Dana recommends saving the carton and contents for use in future reshipping of the instrument. Alternate packing methods, such as plastic foam blocks and loose packing material, may prove to be insufficient for maximum protection and result in damage during shipment. If reshipping is required and the original carton is not available, special packing instructions can be obtained from Dana Labs' Product Service Department.

2.5 The following procedure is performed to verify that no damage has occurred during shipment and that the instrument is operative. Slight deviations in readings during the following tests may be corrected by making simple adjustments. For instructions refer to Section 5, "Calibration". Any major discrepancies should be reported to the carrier and to Dana Laboratories immediately.

2.6 Prior to performing the checkout procedure, it is advisable to refer to the operating instructions beginning with paragraph 2.12. Allow one-half hour for instrument to warm up before proceeding.

2.7 ZERO CHECK.

a. Select DC and auto range.

b. Short SIGNAL input leads. Visual readout should display .000000.

c. If necessary, adjust ZERO OFFSET control on front panel to obtain this reading.

2.8 POLARITY GAIN CHECK.

a. Select DC and 10 range.

b. Apply a known voltage of approximately 10 volts to the SIGNAL input. Visual readout should display value of input voltage (within specified tolerance) and proper polarity.

2.9 RANGE CHECK.

a. Select DC and 100 range.

b. Connect SIGNAL input to a source of +100 volts.

c. Visual readout should display input value (within specified tolerance) and proper polarity.

d. Vary input voltage and polarity; check for proper readout.

e. Repeat the above four steps on 1000-volt range.

f. Select Auto range and repeat the above checks.

2.10 AC CHECK (optional).

a. Select AC, Auto range, and connect signal generator to SIGNAL input. Set generator to 50 Hz.

b. Check for proper readout (within specified tolerance) with each of the following input voltages applied: 9 volts, 90 volts, and 125 volts.

2.11 KILOHMS CHECK (optional).

a. Select Kilohms.

b. Check for proper readout (within specified tolerance) with each of the following resistances connected across the DMM input: 100Ω, 1K, 10K, 100K, 1 Meg, and 10 Megohm.

2.12 OPERATION.

2.13 CONTROLS.

2.14 OFF-ON-HOLD Switch (on mainframe). This dual-purpose switch applies power to the instrument and allows the selection of HOLD.

a. OFF – All power is removed from the instrument.

b. ON – The instrument is operating and taking readings at 3.3 per second.

c. HOLD – Retains and displays the last reading of the instrument until it is switched back to the ON position.

2.15 RATIO X 10 Switch (on mainframe). This pushbutton switch, when depressed, removes the internal reference voltage from the measurement circuits and transfers to an external reference voltage applied at binding posts on the rear panel. The DMM then measures the ratio of the front-panel signal input to the reference voltage (+2 to +12V, DC) applied at the rear panel, and the readout multiplied by 10: E_{sig}/E_{ref} X 10.

2.16 Controls on the Signal Conditioning Module are described in table 2.1.

2.17 ZERO OFFSET.

2.18 DC ZERO OFFSET is adjusted as follows:

a. Select DC and AUTO RANGE.

b. Short SIGNAL HIGH and LOW input leads together.

c. Adjust for a readout of .00000.

2.19 AC ZERO.

2.20 AC zero is a screwdriver adjustment located above the AC pushbutton selector. It is adjusted as follows:

a. Select AC; 1000V range.

b. Short SIGNAL HIGH and LOW input terminals.

c. Adjust for readout of .00000

2.21 KILOHMS ZERO.

2.22 Kilohms zero is a screwdriver adjustment located above the Kilohm pushbutton selector. It is adjusted as follows:

a. Select Kilohms; .1 Kilohm range.

b. Short SIGNAL HIGH and LOW and – CURRENT input terminals.

c. Adjust for readout of .00000.

2.23 ANALOG OUTPUT (OPTION 75).

2.24 With the Analog Output Option, binding posts on the rear panel deliver the d-c analog equivalent of the input (dc, ac, or ohms) at 10 volts full-scale, plus overrange. This output is for use with strip chart recorders, scopes, etc. Output current is 10 ma, maximum.

Table 2.1 - Operating Controls

FUNCTION (pushbutton switches)	FILTER	Places a single-pole filter into the circuit to provide additional noise rejection.
	DC	Selects DC voltage measurements on full-scale ranges of .1V, 1V, 10V, 100V, and 1000V, plus overrange (maximum input: 1000V).
	AC	Selects AC voltage measurements on full-scale ranges of 1V, 10V, 100V, and 1000V, plus overrange (maximum input: 500V at frequency up to 40 KHz, decreasing to 80V at 250 KHz).
	KΩ	Selects resistance measurements on full-scale ranges of .1 Kilohms, 1 Kilohm, 10 Kilohms, 100 Kilohms, 1 megohm, and 10 megohms.
RANGE (pushbutton switches)	AUTO	Selects autorange in which the optimum range is selected automatically by internal circuits. Uprange occurs at 100% of full-scale; downrange occurs at 10% of full-scale (approximately).
	.1, 1, 10, 100, 1000, 10000	Enables manual selection of fixed range. Ranges permissible for each function are identified on the panel.
REMOTE (Slide switch on Model 703 only)	Remote (right position)	Enables the selection of range, function, and mode to be made externally through the remote programming connector.
	Local (left position)	Transfers control of the DMM to the front panel controls.
OFF/ON/HOLD (Rotary switch on 5300 or 5333 module)	OFF	Removes all power from the instrument.
	ON	Applies power to the instrument and enables periodic readings to be taken at the rate of 3.3 per second.
	HOLD	Retains and displays the last reading until switched back to ON position or externally commanded.

2.25 OPERATING INSTRUCTIONS.

2.26 For basic DC or AC measurement, a single-conductor shielded cable is used for interconnection between the signal source and the DMM. The conductor carries the high side of the signal and connects to the HIGH SIGNAL input terminal. The shield connects to the LOW SIGNAL input terminal which is strapped to GUARD (see figure 2.1).

CAUTION

Voltage applied between guard and the low-input terminal must not exceed 250 volts. Voltage applied between guard and the instrument case (Power line ground) must not exceed 500V. Voltage applied between the low-input terminal and the instrument case must not exceed 500V.

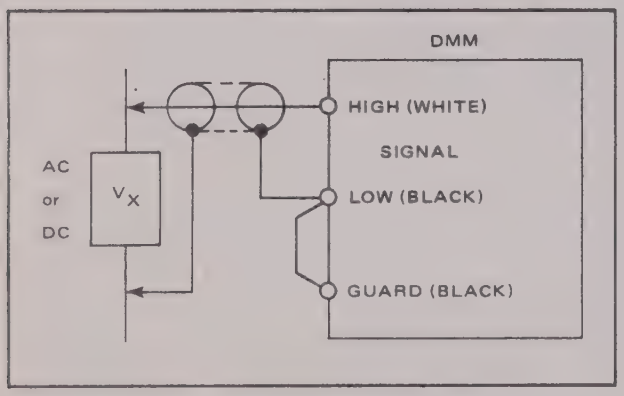


Figure 2.1 - Basic Measurement Connection

2.27 Where common-mode signals are present, a two-conductor shielded cable is required. Connections are made as shown in figure 2.2. The signal input terminals are isolated from the digital section and from power ground.

2.28 DC/DC ratio measurement connections are made as shown in figure 2.3. The signal input can be on any d-c range and the same maximum input voltages apply. The reference voltage can be from +2V to +12V, dc. The readout displays E_{sig}/E_{ref} X 10. Signal and reference input leads are isolated from each other allowing true four-wire ratios.

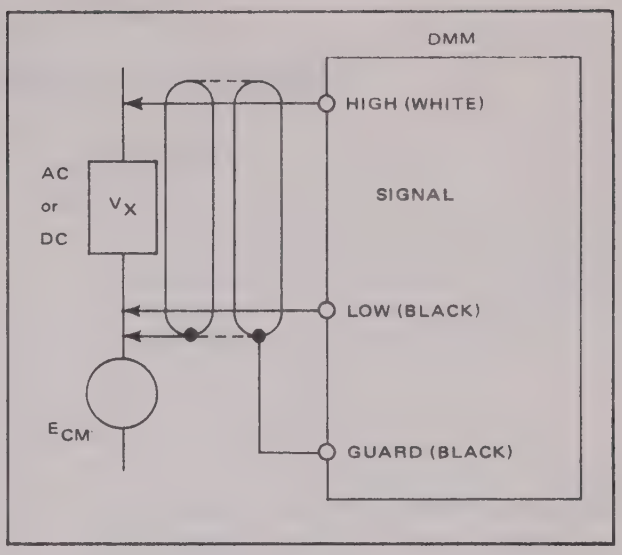


Figure 2.2 - Connections Where CM Present

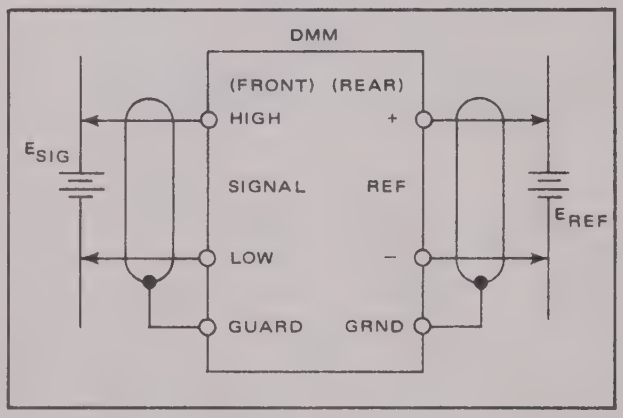


Figure 2.3 - DC/DC Ratio Connections (option 73)

2.29 Four-wire resistance measurements are made as shown in figure 2.4. For maximum accuracy, it is important that the leads be connected to the unknown resistance as shown (± CURRENT leads outside of the ± SIGNAL voltage input leads).

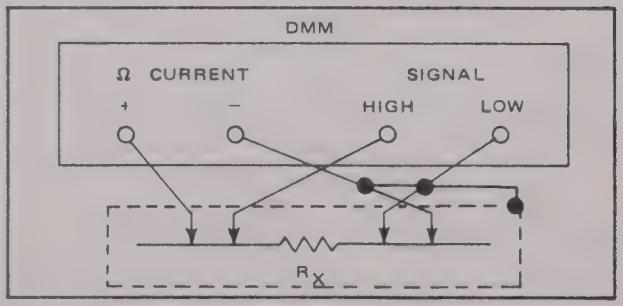


Figure 2.4 - Connections for Resistance Measurement

SECTION 3
REMOTE PROGRAMMING
(Module 703 only)

3.1 PHOTO COUPLERS.

3.2 The isolated remote programming accessory enables the DMM to interface with either grounded or ungrounded equipment while still maintaining a high level of common-mode rejection. Isolation of the guarded circuits of the DMM from the external programming circuits is achieved through the use of optical couplers.

3.3 Each optical coupler (figure 3.1) is a MCT2 type electro-optical isolator. It consists of a light-emitting diode (LED) and a phototransistor. The LED emits light when forward-biased. This light is transmitted through a "light pipe" to the phototransistor. In a phototransistor, base current is generated by light incident on the base-collector junction. The resulting collector current is proportional to the forward-bias current applied to the LED.

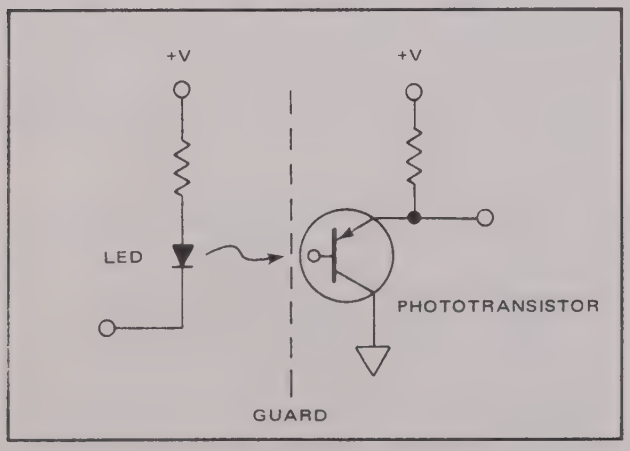


Figure 3.1 - Photo Coupler

3.4 In the DMM, a command at the program input connector forward-biases the LED. Figure 3.2 shows a typical program input line. The typical command, $\overline{X}$, is inverted twice and applied to the anode of the LED. The resulting collector current of the phototransistor produces a $\overline{X}$ at the input of the TTL command logic.

3.5 PROGRAM INPUTS.

3.6 The DMM receives commands through program input connector J33 on the rear panel. Pin assignments of J33 are listed in table 3.1. Command are made either by a switch closure from the selected command to common (pin 24) or by standard TTL logic levels (0 to +0.4 volts false; +2.4 to +5.0 volts true) with respect to common. A false logic level initiates the command.

Table 3.1 - J33 Pin Assignments

PIN	COMMAND	PIN	COMMAND
1	RANGE R1	26	RANGE R4
2	RANGE R2		
4	FUNCTION $\overline{F1}$	29	FUNCTION $\overline{F4}$
5	FUNCTION $\overline{F2}$		
6	FUNCTION $\overline{F8}$	37	$\overline{\text{REMOTE}}$
22	$\overline{\text{DELAYED COMMAND}}$	47	$\overline{\text{HOLD}}$
23	$\overline{\text{DIRECT COMMAND}}$		
24	COMMON	49	$\overline{\text{SUPERFAST}}$
25	NOT USED	50	+5 VOLT REF.

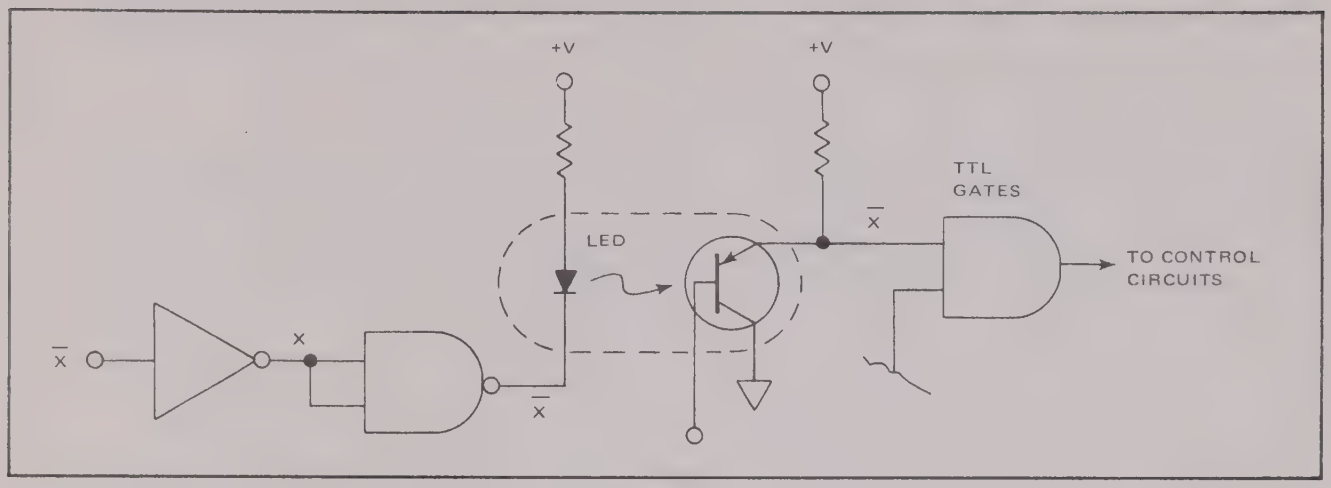


Figure 3.2 - Typical Program Input Circuit

3.7 Range Programming. Codes for range programming are listed below:

Range	Pin 1 R1	Pin 2 R2	Pin 26 R4
.1	0	0	0
1	1	0	0
10	0	1	0
100	1	1	0
1000	0	0	1
10000	1	0	1
AUTO	1	1	1

3.8 Function Programming. Codes for function programming are listed below:

Function	Pin 4 $\overline{F1}$	Pin 5 $\overline{F2}$	Pin 29 $\overline{F4}$	Pin 6 $\overline{F8}$
DC	1	1	1	1
DC FILTERED	1	1	0	1
AC	0	1	1	1
OHMS	1	0	1	1
OHMS FILTERED	1	0	0	1
DC RATIO	1	1	1	0
DC RATIO FILTERED	1	1	0	0

3.9 Read Commands. A closure to common from pin 23 (DIRECT COMMAND) initiates a reading immediately. A closure to pin 22 ($\overline{\text{Delayed Command}}$) starts a new reading after a "timeout" delay to allow for settling time of the input signal. Both commands are used with the DMM in the Hold mode of operation. Timeouts for the various functions when using the Delayed Command are listed below:

Function	Timeout
DC	50 msec
DC FILTERED	500 msec
AC	500 msec
OHMS	50 msec
OHMS FILTERED	500 msec
DC RATIO	50 msec
DC RATIO FILTERED	500 msec

3.10 A command to pin 37, $\overline{\text{REMOTE}}$, overrides all front-panel controls except the power switch. Control of the DMM is then completely through the program input.

3.11 The Hold mode is selected by a command to pin 47, $\overline{\text{HOLD}}$. Each reading is held and no new

measurement made until commanded by either DIRECT COMMAND (pin 23) or DELAYED COMMAND (pin 22).

3.12 A command to pin 49, SUPERFAST, selects a high-speed mode of operation (100 reading per second). In this mode, the DMM functions as a three-digit instrument with some degradation of accuracy.

3.13 A voltage of +5 volts is available at pin 50 for use as a reference level only.

3.14 TYPICAL REMOTE OPERATION.

3.15 A typical wiring arrangement for remote command operation is shown in figure 3.3. REMOTE and HOLD are permanently tied to common. In the figure, the DMM is operating in DC and Auto range since all range and function control lines are "true".

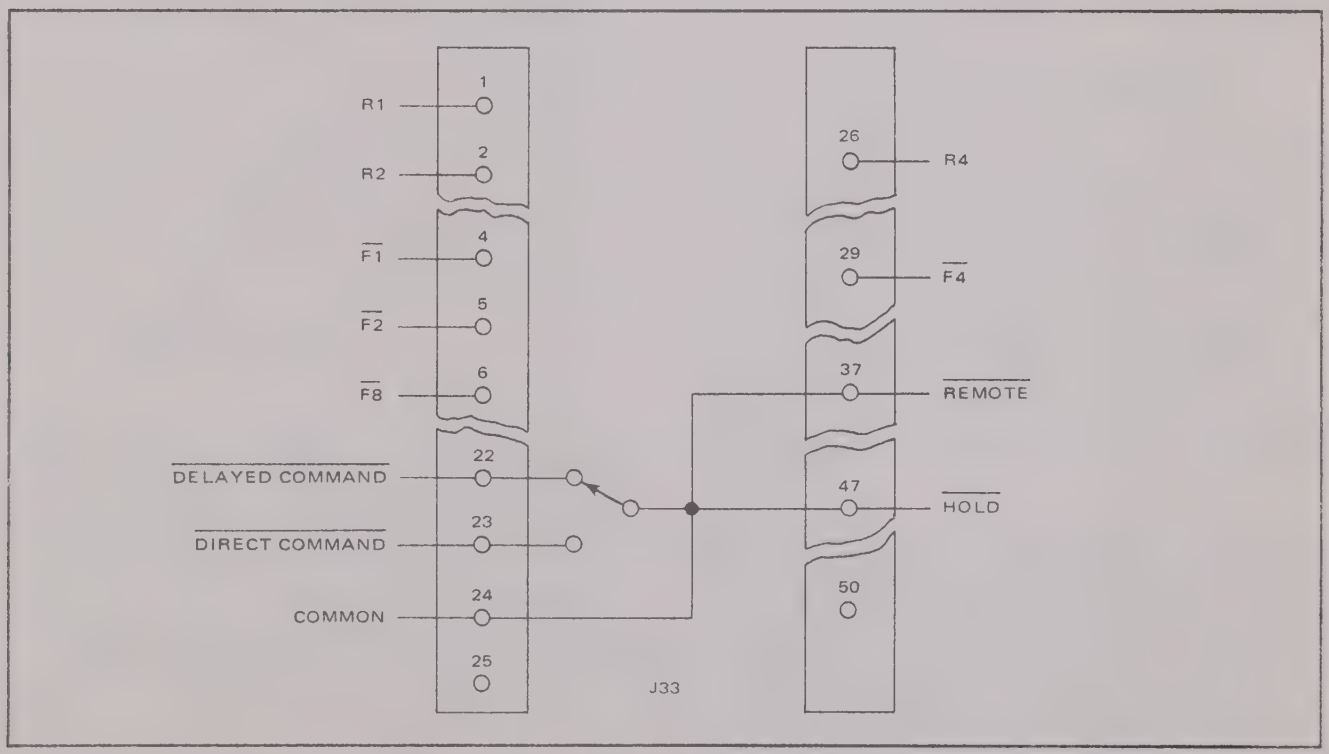


Figure 3.3 - Typical Program Connections

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION.

4.2 The Signal Conditioning Module provides a 10-volt full-scale (12 volts with overrange) analog signal for measurement by the Digitizing and Display Module. The Isolator, range logic circuits and active filter are located on the main board. The AC and Ohms Converters are located on an optional second board which is mounted directly above the isolator board in the module. The output signal from the module may be either a positive or negative voltage when the unit is operating in the DC volts function. Polarity sensing is done in the Digitizing and Display Module. This section assumes the unit to be fully equipped with both AC and Ohms options. For instruments not fully equipped, disregard the appropriate section(s).

4.3 INPUT CIRCUITRY.

4.4 A dc input signal entering the DMM is applied to a relay controlled range divider, scaled, and then applied to the Isolator amplifier. The range divider consists of a set of matched resistors providing 100:1 voltage division. It is switched into the circuit only on DC and only on the 100 and 1000 ranges. A full-scale output of 10 volts from the Isolator is achieved for all ranges by changing the gain of the Isolator and/or switching the range divider.

4.5 An AC input signal is first applied to the AC Converter where it is scaled, rectified, filtered, and then applied to the Isolator.

4.6 For resistance measurements, the Ohms Converter generates a constant current applied through the unknown resistor. The voltage drop across the resistor is measured as a d-c voltage and applied to the Isolator.

NOTE

The partial schematics used in Section 4 are intended to describe operating principles only. Reference designators and component values in these schematics may differ from the complete schematics included in Section 6.

4.7 ISOLATOR (Schematic 430975).

4.8 The Isolator is a floating input potentiometric amplifier capable of operating at very low signal levels. Its output is a 10-volt full-scale analog voltage (12 volts in overrange) that is applied to the Digitizing and Display module for measurement. The amplifier operates at a gain of one, ten, or a gain of one hundred, depending on the range and function to which the DMM is set (see table 4.1). The gain is switched by relays K2 and K3 that control a resistive divider into the feedback circuit when energized.

4.9 The isolator circuitry (figure 4.1) consists of two completely separate amplifiers, one that processes the signal and one that serves only to bootstrap the power supply feeding the front stages of the main amplifier. The output stage is a conventional complementary - symmetry type circuit which operates between the regular positive and negative supplies. The output stage is driven by transistor Q23, which also operates off the main plus and minus voltage sources.

4.10 Transistors Q15 and Q16 form positive and negative current generators which operate from the main positive and negative supply lines. Such current generators exhibit a characteristically high output impedance while providing a known and

Table 4.1 - Range Logic

Range — Function	Range Logic	Divider	Isolator Gain	Relay Position		
				K1	K2	K3
0.1 DC	$\overline{R1}$ $\overline{R2}$ $\overline{R3}$	1	100	Closed	Open	Open
1 DC	R1 $\overline{R2}$ $\overline{R3}$	1	10	Closed	Open	Closed
10 DC	$\overline{R1}$ R2 $\overline{R3}$	1	1	Closed	Closed	Open
100 DC	R1 R2 $\overline{R3}$	100	10	Open	Open	Closed
1000 DC	$\overline{R1}$ $\overline{R2}$ R3	100	1	Open	Closed	Open
AC all ranges		1	1	Closed	Closed	Open
.1 Kilohms	$\overline{R1}$ $\overline{R2}$ $\overline{R3}$	1	100	Closed	Open	Open
1 Kilohm	R1 $\overline{R2}$ $\overline{R3}$	1	10	Closed	Open	Closed
10 Kilohms	$\overline{R1}$ R2 $\overline{R3}$	1	1	Closed	Closed	Open
100 Kilohms	R1 R2 $\overline{R3}$	1	1	Closed	Closed	Open
1000 Kilohms	$\overline{R1}$ $\overline{R2}$ R3	1	1	Closed	Closed	Open
10000 Kilohms	R1 $\overline{R2}$ R3	1	1	Closed	Closed	Open

controlled flow of current through Zener diodes CR21 and CR22. The node where zener diodes CR21 and CR22 join together is connected to the output of the bootstrap amplifier. The bootstrap amplifier is a unity-gain amplifier whose input is connected to the inverting input of the first stage of the isolator amplifier. The neutral point of the zener supplies is thus driven by the bootstrap amplifier and is always at a voltage potential equal to that at the input of the bootstrap amplifier.

4.11 Since the Isolator is a high-gain closed-loop feedback amplifier, the error signal (potential difference) across its inputs (inverting and non-inverting input bases) is always very small and can in most practical cases be ignored. Therefore, the voltage at the inverting input to the Isolator (and at the input to the bootstrap amplifier) is always equal to the input voltage to the Isolator. The bootstrap amplifier, therefore, always drives the neutral node of the zener supplies to the same voltage as the input voltage to the isolator. The net effect is that the entire zener supply rides up and down on the two high impedance current generators. The voltages supplied to the first three stages of the Isolator are always 10 volts above and 7.5 volts below the input signal voltage, regardless of what the input signal voltage may be.

4.12 The input circuitry of the Isolator amplifier (figure 4.2) centers around transistor Q10 which is a dual NPN silicon transistor consisting of two separate transistors on a common substrate. Potentiometer R35, connected between the collector load resistors of the first stage, is the front panel zero adjustment potentiometer. Resistors R31 and R37 are factory selected to electrically center potentiometer R35. The error signal (voltage potential appearing between the bases of Q10) is clamped by back-to-back diodes CR17 and CR18 so that it can not exceed 0.6 volts. The input voltage is clamped by back-to-back zener diodes CR14 and CR15 so that it will not exceed approximately ±13 volts. Diodes CR13 and CR16 compensate for slight leakage in the back-to-back zeners. Zener diodes CR11 and CR12 and resistor R27 prevent excessive voltage at the active filter node which would otherwise damage the filter capacitors. The

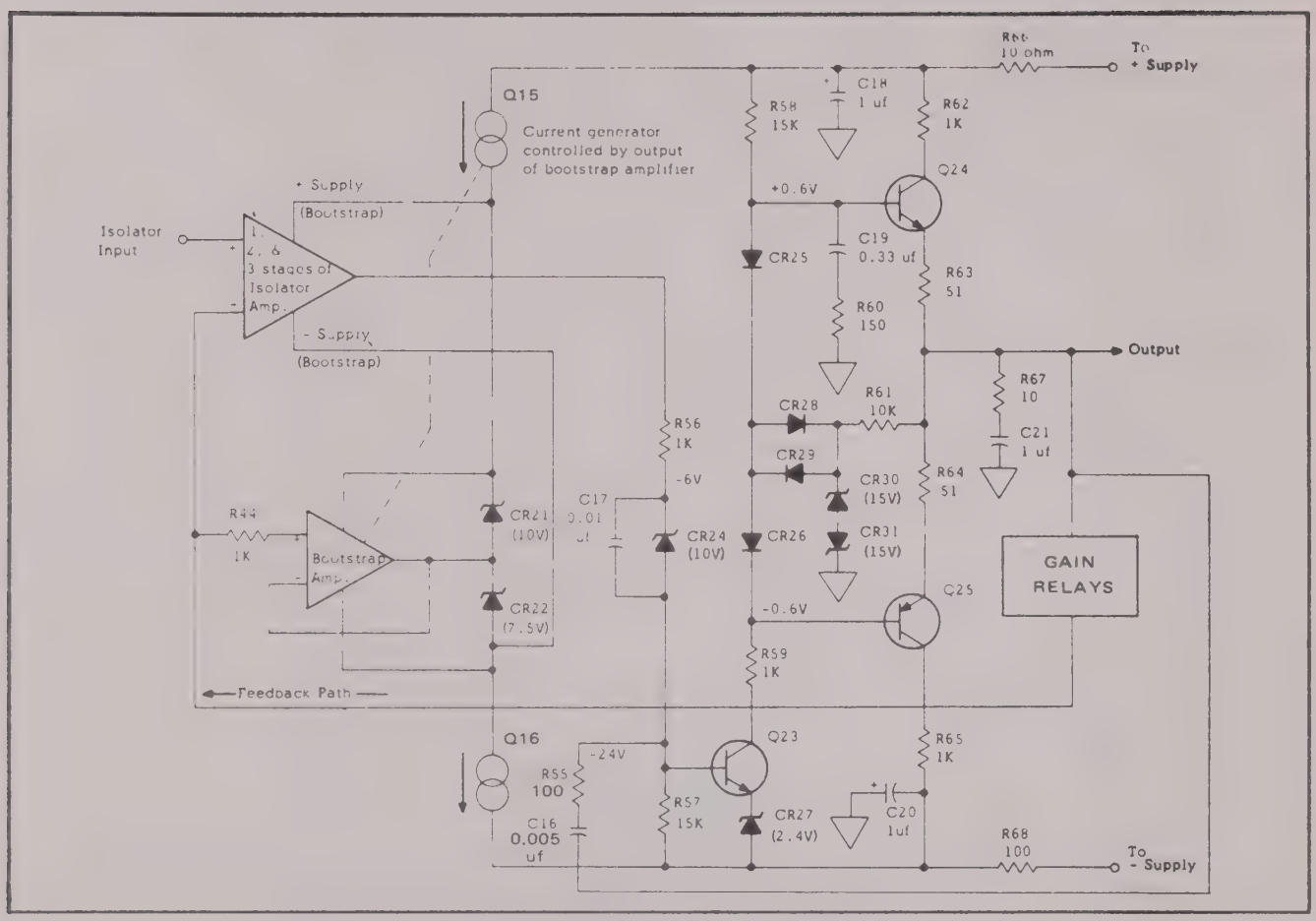


Figure 4.1 - Isolator

input circuit of the Isolator can withstand an input overvoltage condition of up to 1000 volts for any length of time, without damage.

4.13 The network consisting of resistors R24, R25, R26, and R30 and transistor Q9 provides a temperature compensated, adjustable current source to bias the input base of the first stage. Potentiometer R26 is factory adjusted to schedule the optimum input current into the input base so that no current is taken from the circuit to which the DMM is connected. The biasing network is connected to the bootstrapped supply which is always referenced to the input signal thus achieving a high input impedance.

4.14 MODEL 51 AC CONVERTER (Schematic 430968).

4.15 The Model 51 AC Converter is a broadband AC Converter (30 Hz to 250 KHz) that operates on four ranges. With AC selected, the DMM input is routed through the AC Converter that rectifies and filters the signal before it is applied to the Isolator.

4.16 A simplified diagram of the AC Converter is shown in figure 4.3. The input signal is applied to an operational amplifier. Gain is established by relay-controlled range resistors in the feedback circuit.

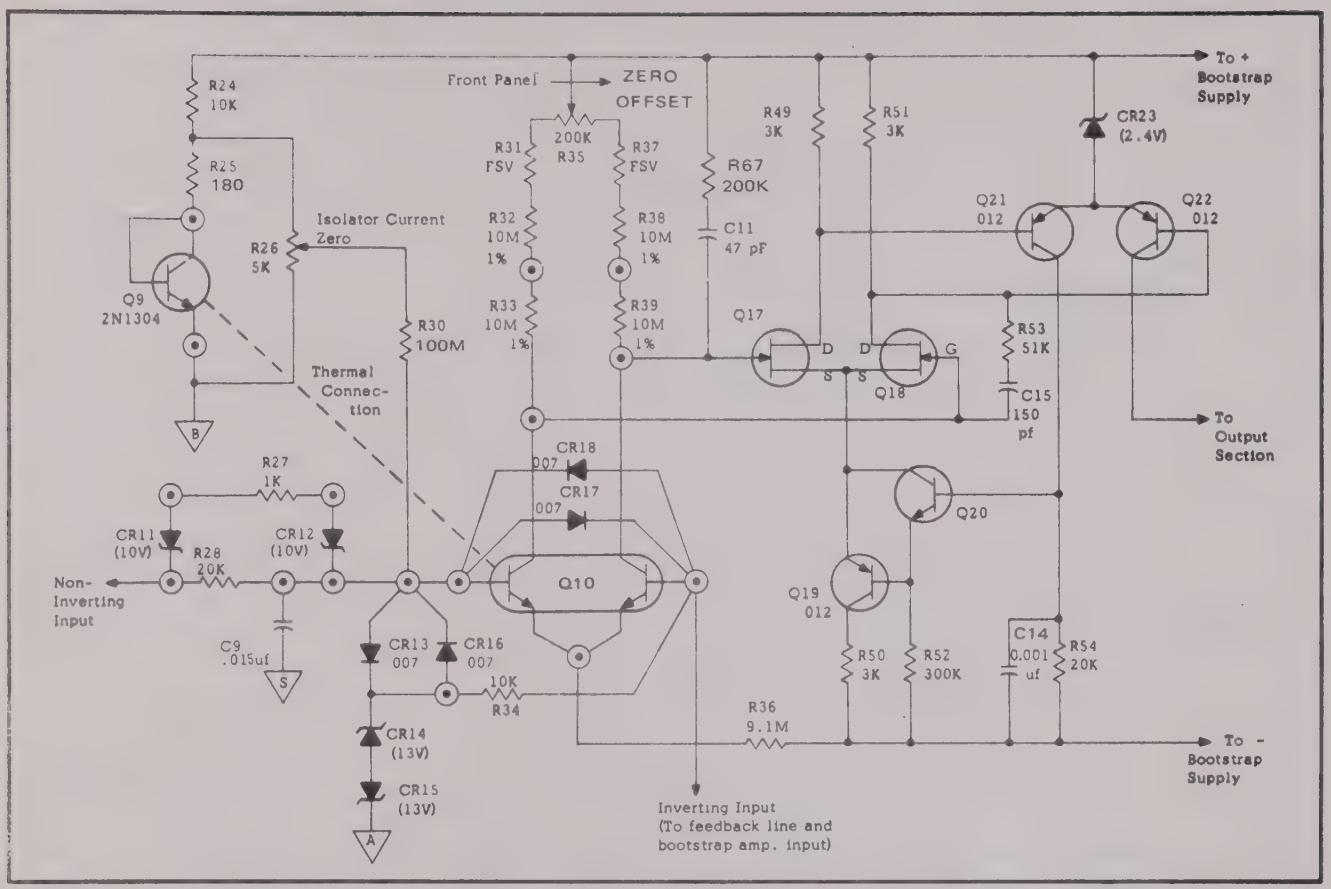


Figure 4.2 - Isolator Amplifier Input Circuitry

4.17 Rectification and filtering is accomplished at the output of the operational amplifier by diodes CR5 and CR6 and a passive R-C filter. Each diode conducts during one-half of each cycle (assuming sine input) and provides one differential input to the output amplifier. The AC Converter output is a full-wave rectified, filtered, d-c equivalent of the average a-c input. This voltage is applied to the Isolator.

4.18 MODEL 61 OHMS CONVERTER (Schematic 430969).

4.19 The Model 61 Ohms Converter enables four-wire resistance measurements on six ranges. The four-wire technique minimizes measurement errors due to lead resistance. A diagram of the Ohms Converter is shown in figure 4.4. It is important that the leads be connected to the unknown resistance (R_X) with the exact placement shown, especially for low resistance measurements.

4.20 An operational amplifier is used to generate a precise fixed current that is applied through the unknown resistance. The resulting voltage drop across the resistance (Ohms Converter output voltage) is sent on to the Isolator.

4.21 Figure 4.5 is an equivalent circuit showing R_X in the feedback path of the amplifier.

4.22 The constant current generated for each range is $I = \frac{E_{Ref}}{R_r}$. The value of R_r, for each range, is equal to the full scale value of the selected range.

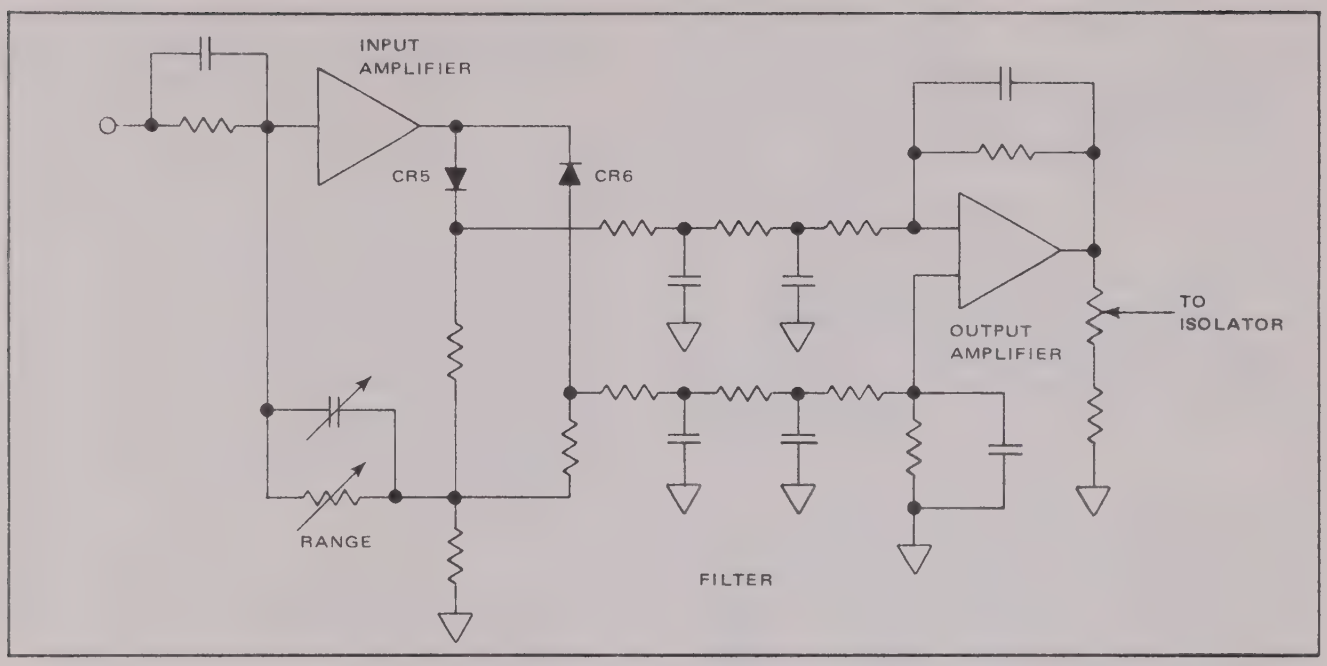


Figure 4.3

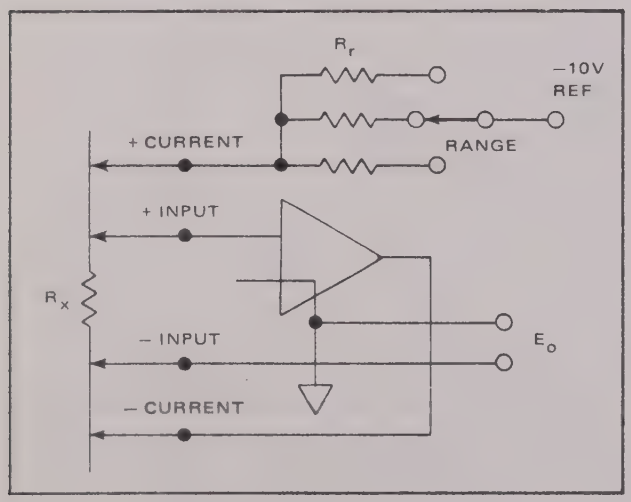


Figure 4.4 - Ohms Converter

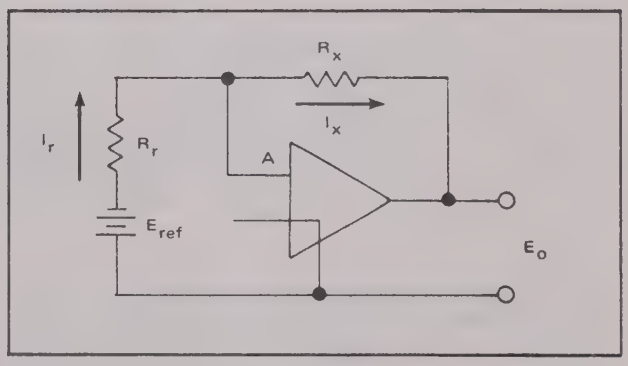


Figure 4.5 - Equivalent Circuit

That is, 10 Kilohms on 10 Kilohm range, etc. An operational amplifier has the characteristic of zero current and zero voltage at its input. All current flowing to point A (figure 4.5) also flows from point A ($I_r = I_x$). The current generated is therefore independent of R_x. E_{Ref}/R_r for each range is listed below:

10 Megohm range, 1 μa
1 Megohm range, 10 μa
100 Kilohm range, 100 μa
10 Kilohm range, 1 ma
1 Kilohm range, 1 ma
.1 Kilohm range, 1 ma

4.23 The three lowest ranges operate on the same value of R_r. In these ranges, gain of the Isolator is varied to obtain correct output voltages.

4.24 Output voltage of the converter is: $E_o = E_{ref} (\frac{R_x}{R_r})$. Full scale readings ($\frac{R_x}{R_r} = 1$) on the 10, 100, 1000, and 10,000 kilohm ranges result in an output voltage of 10 volts from the Ohms Converter. In all of these ranges, the gain of the Isolator is set to one – providing a 10-volt full-scale output to the digital circuits. In the .1 kilohm range, full-scale output voltage is .1 volt and the gain of the Isolator is set to 100. In the 1 kilohm range, full-scale output is 1 volt and the gain of the Isolator is 10.

4.25 The circuit minimizes errors due to lead resistance. In figure 4.6, R1 through R4 represents

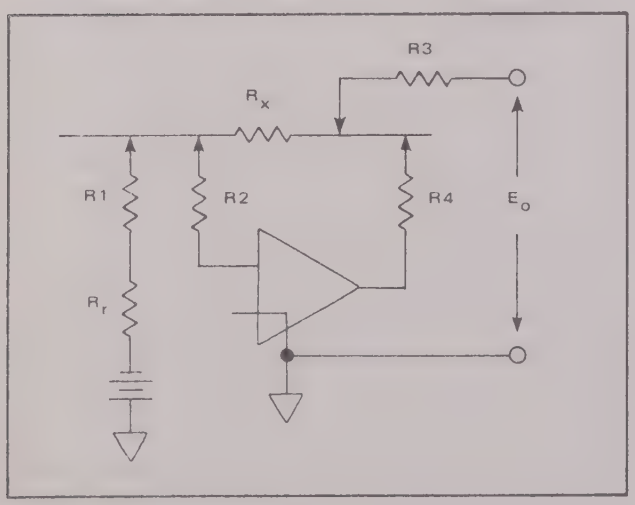


Figure 4.6 - Ohms Converter Lead Resistance

lead resistance. Since current flow through R2 and R3 is negligible, there is no voltage drop and no error produced. R4 is within the feedback loop (if connected to R_X properly) and will cause no error since $I_X R_X + I_X R_4$ is within the linear region of the amplifier. Error can be caused, however, by R1. Considering lead resistance, the output voltage is $E_o = E_{ref} \frac{R_x}{R_r + R_1}$. Therefore, the error due to R1 is a per cent of reading error (not full-scale error) and is eliminated by calibration providing that the lead resistance is constant and stable.

4.26 RANGE CONTROL.

4.27 Ranging of the instrument is controlled by a three-stage flip-flop counter (M2 and M5) driven by control signals from the Digitizing and Display Module. The control signals are Up Range, Down Range, and $\overline{\text{Strobe}}$.

4.28 Up Range is true when the instrument is not on the highest range and the counter in the Digitizing and Display Module registers 120000 or higher. Down Range is true when the instrument is not in the lowest range and the counter in the Digitizing and Display Module registers 009999 or less. Strobe is true during the measurement period. The negative-going edge of this signal indicates the end of the measurement.

4.29 The range counter counts up or down in response to the Up Range and Down Range control signals. The state of the flip-flops corresponds to the codes and ranges listed in table 4.2. A manually selected range "forces" the flip-flops to the proper state by clamping the appropriate counter outputs to common.

4.30 A one-shot circuit provides a timeout (delay) of about 0.5 seconds at the end of a measurement period to allow time for ranging and for settling time of analog circuits. During this period, the HOLD line goes positive. This line is tied to the input of the control logic circuits in the Digitizing and Display Module where the positive level prevents a new reading from being taken.

4.31 When operating in a selected range, rather than auto range, the HOLD line is permanently strapped to common by the range switch and new readings are allowed during a range changing attempt.

Table 4.2 - Range Codes

RANGE	R1	R2	R3
.1	0	0	0
1	1	0	0
10	0	1	0
100	1	1	0
1000	0	0	1
10000	1	0	1

SECTION 5

CALIBRATION

5.1 INTRODUCTION.

5.2 This calibration procedure is designed to keep the Digital Multimeter operating within its specifications. Any necessary maintenance should be done prior to calibration. The calibration steps in this procedure rely on the adjusted accuracy of the preceding step, therefore care must be taken to make each adjustment in the order that it appears in this procedure.

5.3 EQUIPMENT REQUIRED.

5.4 The following equipment, or an acceptable equivalent, is required for DMM calibration and is listed in the order of use. The test equipment specifications listed are recommended by Dana as necessary to give satisfactory calibration.

I. Basic DC Calibration of the Instrument.

a. A precision DC voltage standard (calibrator) variable from 0 to 1000 volts having a resolution of 100 microvolts or better at 10 volts (10 PPM), and an accuracy of .003% with a stability of .001%. For example, the Fluke model 332A or the Cohu model 351.

b. A guarded absolute ratio voltbox capable of precision voltage division of 100:1, 10:1, and 1:1 with a resolution of 1/2 part per million. The input resistance should be 50 kilohms, minimum, at a ratio of 10:1 and 500 kilohms, minimum, at a ratio of 100:1. An ESI model 1040A is recommended. (This instrument, when used in conjunction with the DC standard and a standard cell traceable to N.B.S., can normalize the DC standard to the traceable source.)

c. A precision decade voltage divider capable of 10:1 and 100:1 division, having an input resistance of 10,000 ohms minimum, an output resistance of 5000 ohms maximum, and an accuracy of .005% or better. For example, the ESI model RV-622A.

d. A one megohm 5% carbon resistor.

II. AC Calibration (required only if the instrument has the AC option).

a. An AC laboratory power source, variable from 0 to 500 volts and 50 Hz to 250 KHz, having a resolution better than 100 PPM, harmonic distortion of 0.1% or less and a stability of .01%. For example, the Optimation type AC 104, (oscillator, matching transformer, and power amplifier).

b. An AC/DC laboratory transfer standard (for calibration of the AC source) having an accuracy of .05% or better. For example, the Holt Model 6 Thermal Transfer Voltmeter.

III. Ohms Calibration (required only if the instrument has the OHMS option).

a. Standard resistors: 100, 1K, 10K, 100K, and 1 Megohm with value known to within .005%; and a 10 Megohm with value known to within .01%. For example, the ESI SR 1 series standard resistors.

5.5 TOOLS.

a. An insulated blade-type calibration tool.

b. A No. 1 Phillips screwdriver.

5.6 PREPARATION.

a. Remove the two screws which secure the top and bottom covers of the instrument. Slide the top cover back and remove it.

b. Set the DMM controls as follows:

Function: DC volts
Range: Auto
Ratio Switch: Out (if applicable)

c. Set the OFF-ON-HOLD switch on the front of the instrument to the ON position.

d. Connect the GUARD terminal on the front of the instrument to the LO input terminal. Connect a test lead to the HI (only) input terminal of the instrument.

5.7 POWER SUPPLY CHECK (Refer to Figure 5.1).

a. Using the test lead installed in the preceding step, the instrument can measure its own operating voltages at the four test points listed below. If any of the voltages do not measure within the tolerances indicated the defective power supply must be repaired before any further calibration is attempted. (NOTE: The uncalibrated accuracy of the instrument is normally adequate for measuring these voltages within the specified limits unless the unit is in need of repair.)

Test Point	Voltage
I	+15 volts ± 10% ± 1.5
Z	−21.6 volts ± 10% ± 2
T	−15 volts ± 10%
Y	+3.6 volts ± 0.1 volt (If not within tolerance adjust potentiometer R-8 on the Power Supply Module to set the voltage to +3.6 volts)

b. Remove the test lead from the "HI" input terminal.

c. Short the "HI" and the "LO" input terminals of the instrument together. (NOTE: This clip lead must use plain, unplated copper clips. Cadmium plated clips act like thermocouples, generating enough voltage to cause several digits of zeroing error in some cases.)

d. Replace the top cover on the unit and allow at least 30 minutes for the instrument to reach a stable internal ambient operating temperature.

5.8 ANALOG ZERO ADJUSTMENT.

a. With the two SIGNAL input terminals jumpered together, place the instrument (manually) in the .1 volt DC range.

b. Adjust the ZERO OFFSET potentiometer on the front of the Signal Conditioning Module to obtain a reading of .000000.

5.9 INTEGRATOR ZERO ADJUSTMENT.

a. Jumper the input terminals together on the front panel. Place the DMM in the DC Function and the 10 Range. Allow the DMM five minutes warm up.

b. Slide the top cover to the rear of the DMM to expose the Integrator Zero Adjustment Control R-63. Refer to figure 5.1 for location.

c. Adjust the Integrator Zero Control R-63 such that the Polarity Indicators are alternately displaying plus and minus.

d. Remove the short between the "High" and "Low" Input terminals.

e. Connect the test equipment and the instrument under calibration as shown in figure 5.2. Connect the test leads from the decade voltage divider to the DMM. Connect the input voltage to the DMM with the negative tied to the "High" Input Terminal of the DMM.

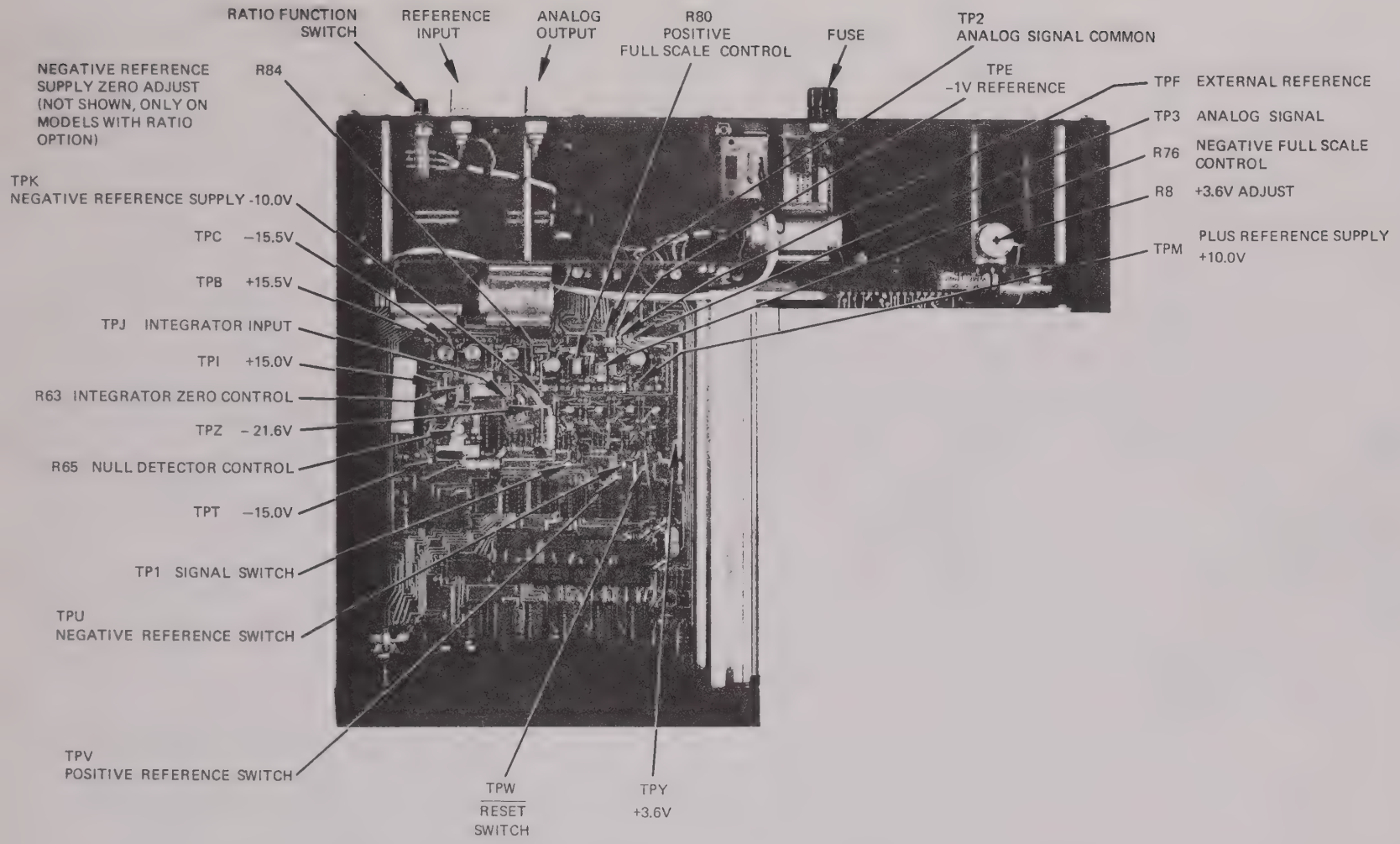
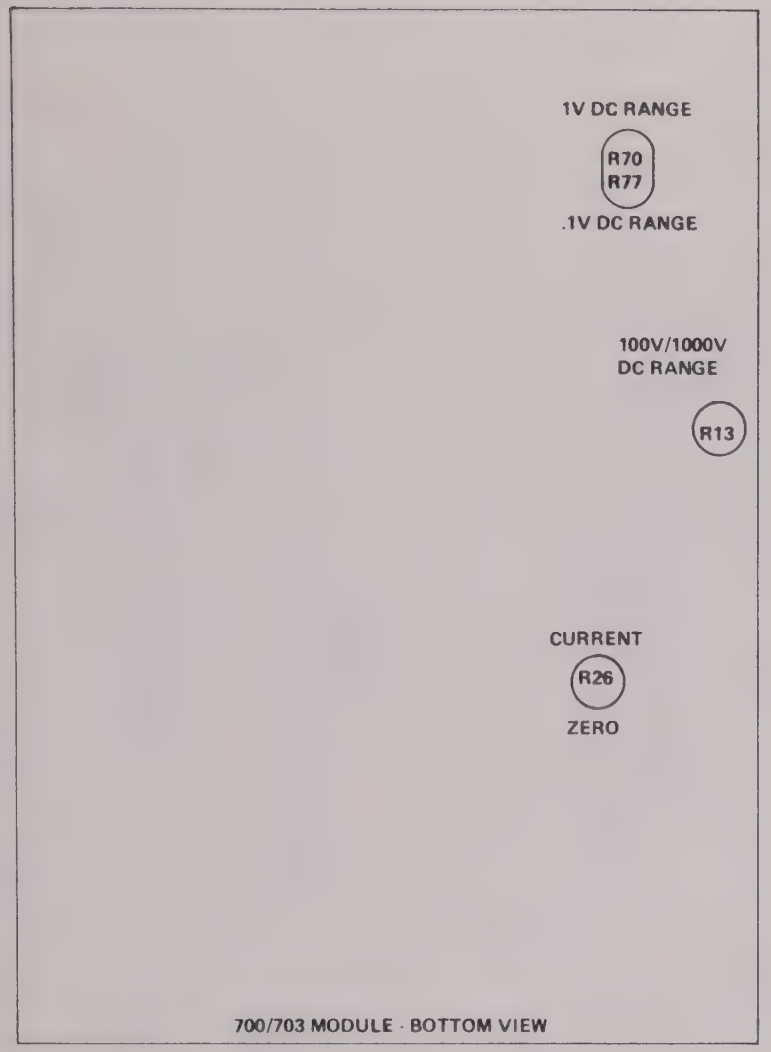

RATIO FUNCTION SWITCH
REFERENCE INPUT
ANALOG OUTPUT
R80 POSITIVE FULL SCALE CONTROL
FUSE
TP2 ANALOG SIGNAL COMMON
NEGATIVE REFERENCE SUPPLY ZERO ADJUST (NOT SHOWN, ONLY ON MODELS WITH RATIO OPTION)
R84
TPE -1V REFERENCE
TPF EXTERNAL REFERENCE
TP3 ANALOG SIGNAL
R76 NEGATIVE FULL SCALE CONTROL
R8 +3.6V ADJUST
TPM PLUS REFERENCE SUPPLY +10.0V
TPK NEGATIVE REFERENCE SUPPLY -10.0V
TPC –15.5V
TPB +15.5V
TPJ INTEGRATOR INPUT
TPI +15.0V
R63 INTEGRATOR ZERO CONTROL
TPZ – 21.6V
R65 NULL DETECTOR CONTROL
TPT –15.0V
TP1 SIGNAL SWITCH
TPU NEGATIVE REFERENCE SWITCH
TPV POSITIVE REFERENCE SWITCH
TPW RESET SWITCH
TPY +3.6V

Figure 5.1a



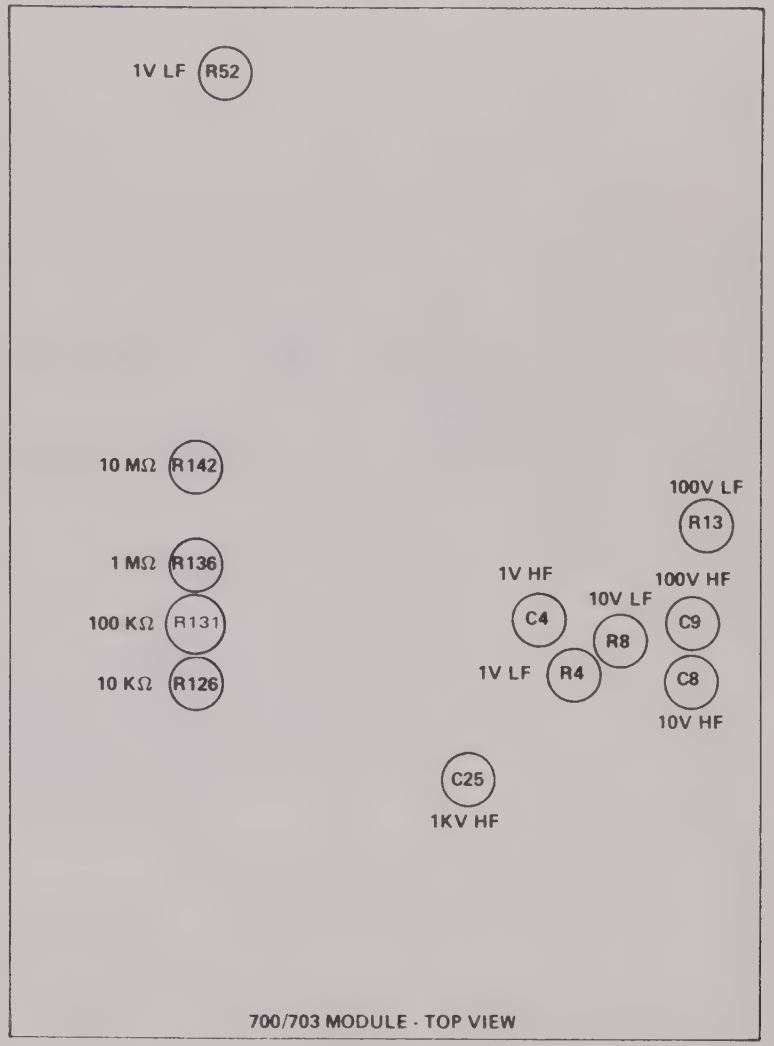


Figure 5.1b - Adjustment Locations

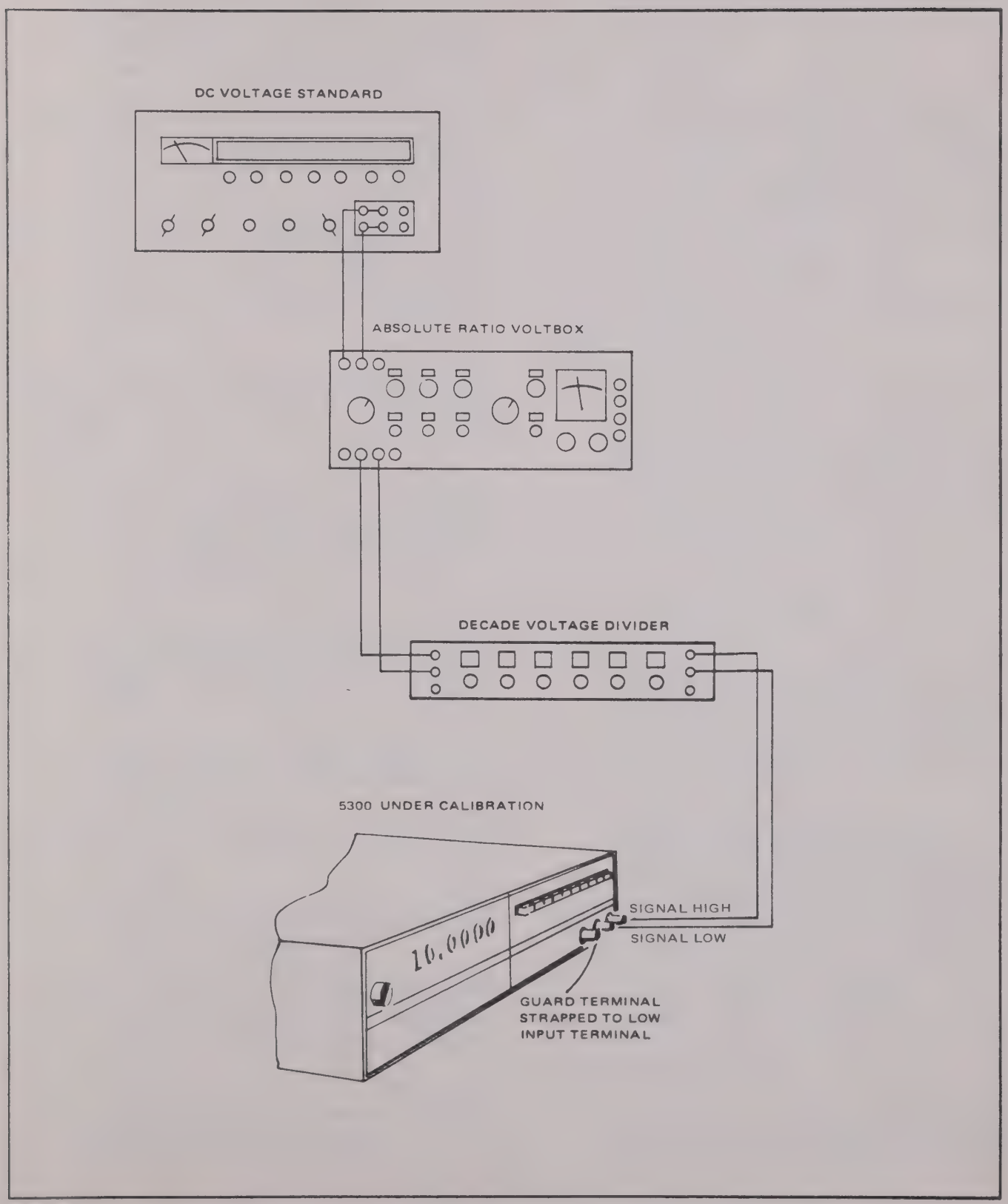


Figure 5.2 - Setup for calibration of lower DC voltage ranges

f. Apply an input voltage of −0.001 VDC to the DMM. Note the reading. Apply an input voltage of +0.001 VDC. Note the second reading and compare with the first reading. If the adjustment of the integrator zero control is correct the voltage in both cases will be the same but the polarity will change with the input polarity. Adjust the Null Detector Control (R65) on the display board for a display of 10 digits or 1 millivolt. Verify that the DMM reads + or − 1 millivolt with the signal on the input. Also verify that the DMM displays alternately plus and minus and all zeros with the input shorted. If necessary, repeat steps 5.9 (a) through (f).

5.10 VOLTAGE CALIBRATION OF THE DIGITIZING AND DISPLAY MODULE (Refer to Figure 5.2).

a. Set the voltage standard to −10.0000 volts and the absolute ratio voltbox to 1.0 (1:1). Set the decade voltage divider to .999999. This applies an input signal of −9.99999 volts to the DMM.

b. Slide the top cover of the instrument back just enough to expose potentiometer R-76 (negative full-scale adjustment potentiometer).

c. Adjust R-76 so that the indication on the readout alternates between −9.9999 and −10.0000.

d. Slide the top cover forward over the instrument.

e. Reverse the polarity of the input signal so that it is now +9.99995 volts.

f. Slide the top cover of the instrument back just enough to expose potentiometer R-80 (positive full-scale adjustment potentiometer).

g. Adjust R-80 so that the readout alternates between +9.9999 and +10.0000.

h. Slide the top cover forward over the instrument and wait a minimum of five minutes to allow the internal temperature to re-stabilize.

i. Verify that the indication on the instrument's readout still reads +10.0000 with an input signal of 9.99999 volts. Similarly verify that the reading will read −10.0000 with an input −9.99999 volts. If necessary, repeat the adjustments of R-76 and R-80 outlined in steps 5.10 (a) through 5.10 (h) to obtain the specified readings.

5.11 ADJUSTMENT OF ANALOG CURRENT ZERO (Refer to Figure 5.1).

a. Place the instrument on its side in a manner such that the adjustment potentiometers located on the bottom side of the Signal Conditioning Module can be adjusted when the bottom cover has been slid back far enough to expose them. Leave the bottom cover in place at this time.

b. Place the instrument in the DC VOLTS function and Auto range.

c. Connect a 1 Megohm 5% carbon resistor across the input terminals of the instrument by loosening the binding posts, placing the resistor leads through the binding post holes and tightening the binding posts on the resistor leads.

d. Connect a short clip lead across the input terminals of the instrument. (NOTE: This clip lead must use plain, unplated copper clips. Cadmium plated clips act like thermocouples, generating enough voltage to cause several digits of zeroing error in some cases.)

e. Verify a readout of +.000000. Adjust ZERO OFFSET, if necessary.

f. Remove the clip lead.

g. Slide the bottom cover of the instrument back just enough to expose potentiometer

R-26 (the Isolator Current Zero potentiometer).

h. Adjust R-26 to obtain a reading of .000000 ± 15 digits.

i. Re-check steps d through h above to eliminate any interaction.

j. Remove the 1 Megohm resistor from the DMM input terminals.

5.12 DC VOLTAGE CALIBRATION OF THE SIGNAL CONDITIONING MODULE (Refer to Figure 5.3).

a. Connect the test equipment and the instrument under calibration as shown in fig-

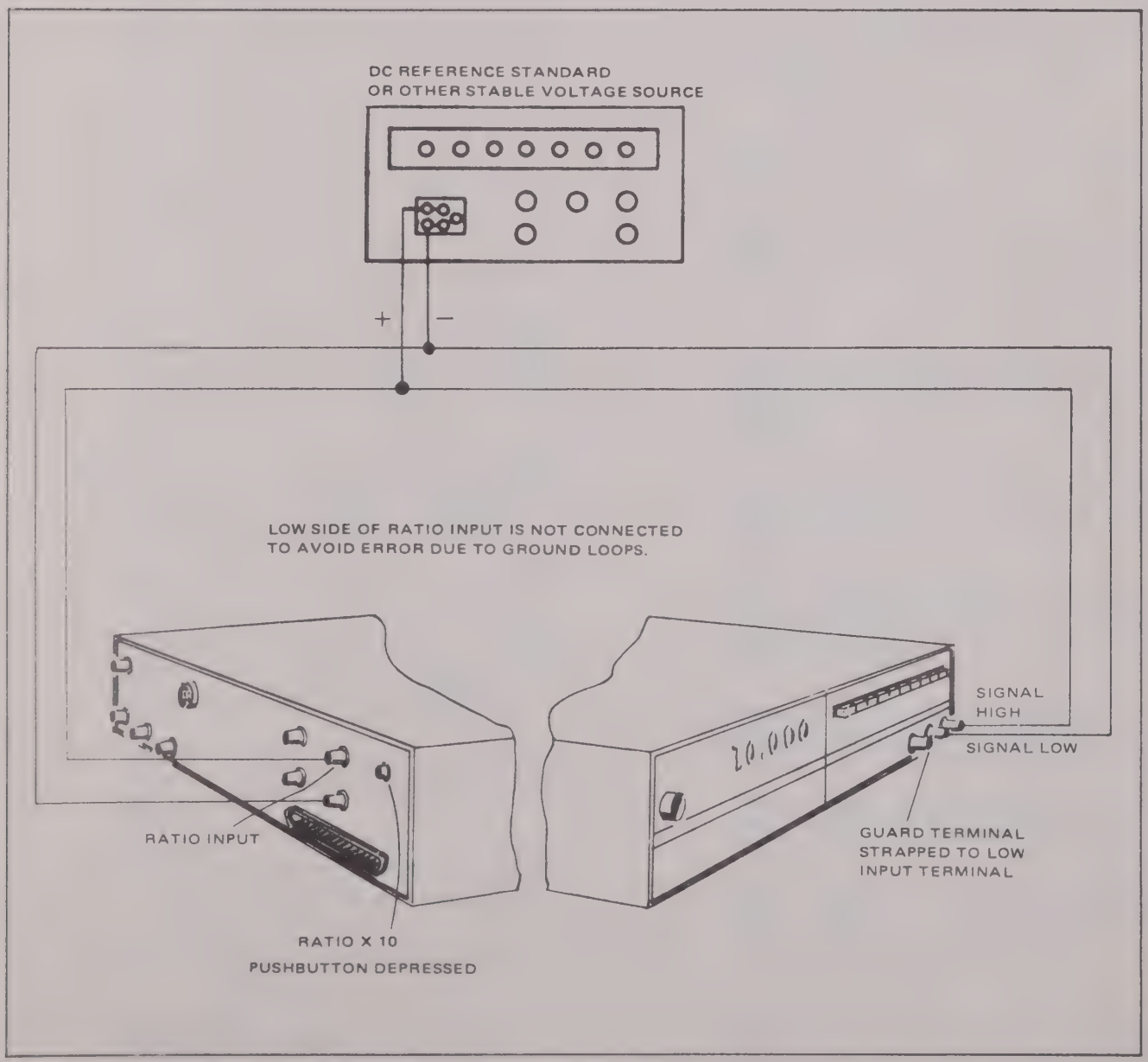


Figure 5.3 - Ratio measurement accuracy test setup

ure 5.3. Set all dials on the voltage standard and decade voltage divider to zero.

b. Set the DMM controls as follows:

Function: DC volts
Range: Auto
Ratio X10 Switch: Out (if applicable)

c. Verify that the DMM readout indicates all zeros and "bounces" between + and — polarity indicators. If necessary, adjust the ZERO OFFSET potentiometer on the front of the instrument.

d. Set the DC voltage standard to 10.0000 volts.

e. Set the absolute ratio voltbox to X.01 (100:1).

f. Set the decade voltage divider to .9999995.

g. Slide the bottom cover of the instrument back just enough to expose the calibration potentiometers on the bottom of the signal conditioning module.

h. Adjust potentiometer R-77 (the "0.1 CAL" potentiometer) so that the readout alternates between .099999 and .100000.

i. Set the absolute ratio voltbox to X.1 (10:1).

j. Adjust potentiometer R-70 (the "1V CAL" potentiometer) so that the readout alternates between 0.99999 and 1.00000.

k. Set the absolute ratio voltbox to X.01 (100:1) or disconnect it from the DC voltage standard.

l. Connect the DMM input directly to the DC voltage standard as shown in figure 5.4.

m. Adjust the output of the DC voltage standard to 99.9995 volts.

n. Adjust potentiometer R-13 (the "100/1000V CAL" potentiometer) so that the readout alternates between 99.999 and 100.000.

5.13 AC CALIBRATION.

a. Select AC; 1000V Range.

b. Short SIGNAL input terminals.

c. Adjust AC OFFSET for readout of .00000.

d. Remove short from input and set following adjustments to the center of their mechanical span:
R52, R4, R8, R13

e. Select 1V range.

f. Apply 1V rms @ 400 Hz to input. Adjust R52 for readout of approximately 1.00000.

g. Adjust R4 for readout of exactly 1.00000.

h. Increase input to 10V rms; select 10V range. Adjust R8 for readout of exactly 10.0000.

i. Increase input to 100V rms; select 100V range. Adjust R13 for readout of exactly 100.000.

j. Select 1000V range; apply input voltage of 100V rms @ 100 KHz. Adjust C25 for readout of 100.000.

k. Change input to 1V rms; select 1V range. Adjust C4 for readout of 1.00000.

l. Increase input to 10V rms; select 10V range. Adjust C8 for readout of 10.0000.

m. Increase input to 100V rms; select 100V range. Adjust C9 for readout of 100.000.

5.14 OHMS CALIBRATION.

a. Select Kilohms function, .1 Kilohm Range, Ratio out.

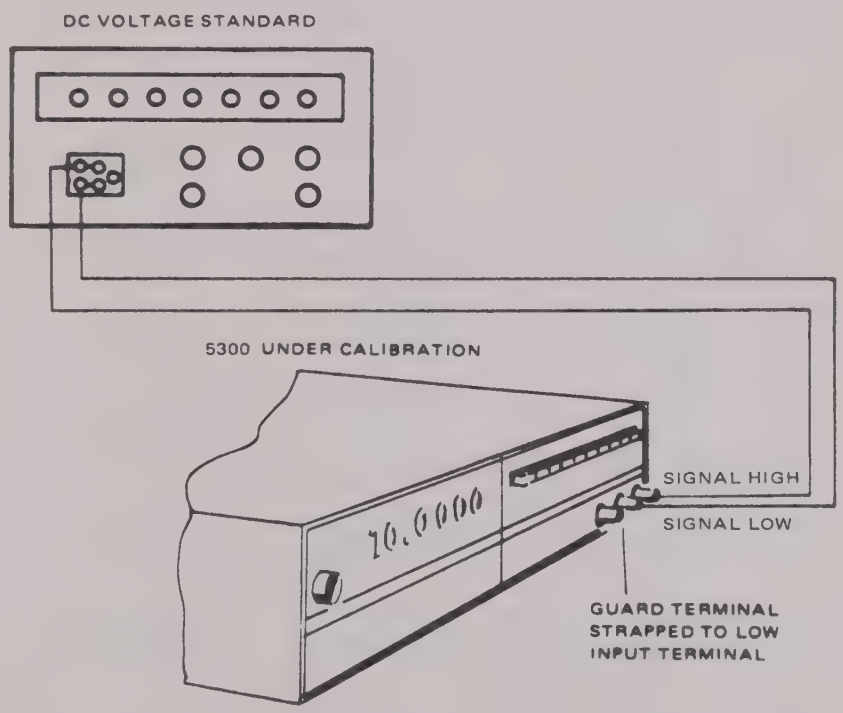


Figure 5.4 - Setup for 100V and 1000V DC range calibration

Table 5.1 - Allowable Error in Digits in AC volts function

If the Input Signal, on any given range is:	The maximum number of digits error from 30 Hz to 50 Hz is:	The maximum number of digits error from 50 Hz to 30 kHz is:	The maximum number of digits error from 30 kHz to 100 kHz is:	The maximum number of digits error from 100 kHz to 250 kHz is:
0% of full scale (Input shorted)	± 20 digits	± 20 digits	± 20 digits	± 20 digits
10% of full scale	± 40 digits	± 30 digits	± 35 digits	± 300 digits
20% of full scale	± 60 digits	± 40 digits	± 50 digits	± 500 digits*
30% of full scale	± 80 digits	± 50 digits	± 65 digits	± 700 digits
40% of full scale	± 100 digits	± 60 digits	± 80 digits*	± 900 digits
50% of full scale	± 120 digits*	± 70 digits*	± 95 digits	± 1100 digits
60% of full scale	± 140 digits	± 80 digits	± 110 digits	± 1300 digits
70% of full scale	± 160 digits	± 90 digits	± 125 digits	± 1500 digits
80% of full scale	± 180 digits	± 100 digits	± 140 digits	± 1700 digits
90% of full scale	± 200 digits	± 110 digits	± 155 digits	± 1900 digits
100% of full scale	± 220 digits	± 120 digits	± 170 digits	± 2100 digits
110% of full scale	± 240 digits	± 130 digits	± 185 digits	± 2300 digits
120% of full scale	± 260 digits	± 140 digits	± 200 digits	± 2500 digits

*Refer to Table 5.2. Maximum input on 1000V AC range is 500V RMS (30 Hz to 40 kHz) decreasing to 100V RMS at 100 kHz.

Table 5.2 - Maximum AC Input on 1000 VAC Range

Maximum percentage of full scale AC RMS input on the 1000V AC range is 500V RMS from 30 Hz to 40 kHz decreasing to 80V RMS at 250 kHz.

Frequency	Maximum AC Input Voltage
30 Hz to 40 kHz	500V RMS
50 kHz	430V RMS
60 kHz	365V RMS
70 kHz	300V RMS
80 kHz	230V RMS
90 kHz	165V RMS
100 - 200 kHz	100V RMS
225 kHz	85V RMS
250 kHz	80V RMS

b. Short the HIGH and LOW input and the —Ohms Current input leads together.

c. Adjust Kilohm zero control (screwdriver adjustment above Kilohms pushbutton selector) for a readout of .000000.

d. Select 10,000 Kilohm range. Connect test leads to a 10 Megohm standard resistor. Adjust 10 Megohm Range pot R142 for a readout of 10000.0 ± 32 digits.

e. Select 1000 Kilohm range. Connect test leads to a 1 Megohm standard resistor. Adjust 1 Megohm range pot R136 for a readout of 1000.00 ± 17 digits.

f. Select 100 Kilohm range. Connect input leads to a standard 100 Kilohm resistor. Adjust the 100 Kilohm range pot R131 for a readout of 100.000 ± 12 digits.

g. Select 10 Kilohm range. Connect input leads to a standard 10 Kilohm resistor. Adjust the 10 Kilohm range pot R126 for a readout of 10.0000 ± 12 digits.

h. Select 1 Kilohm range. Connect input leads to a standard 1 Kilohm resistor. Verify a readout of 1.00000 ± 12 digits.

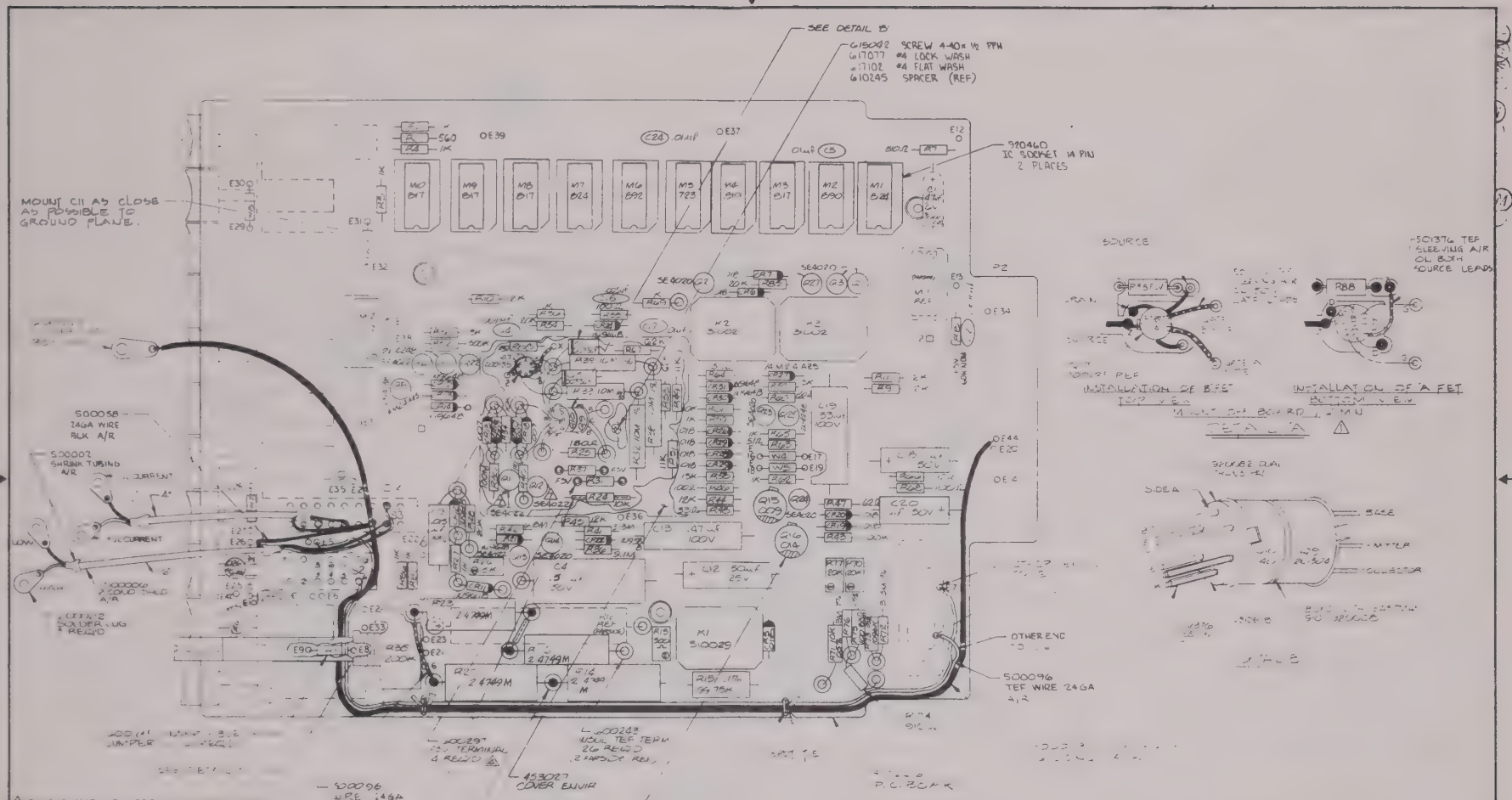
i. Select .1 Kilohm range. Connect input leads to a standard 100 Ohm resistor. Verify a readout of .100000 ± 25 digits.

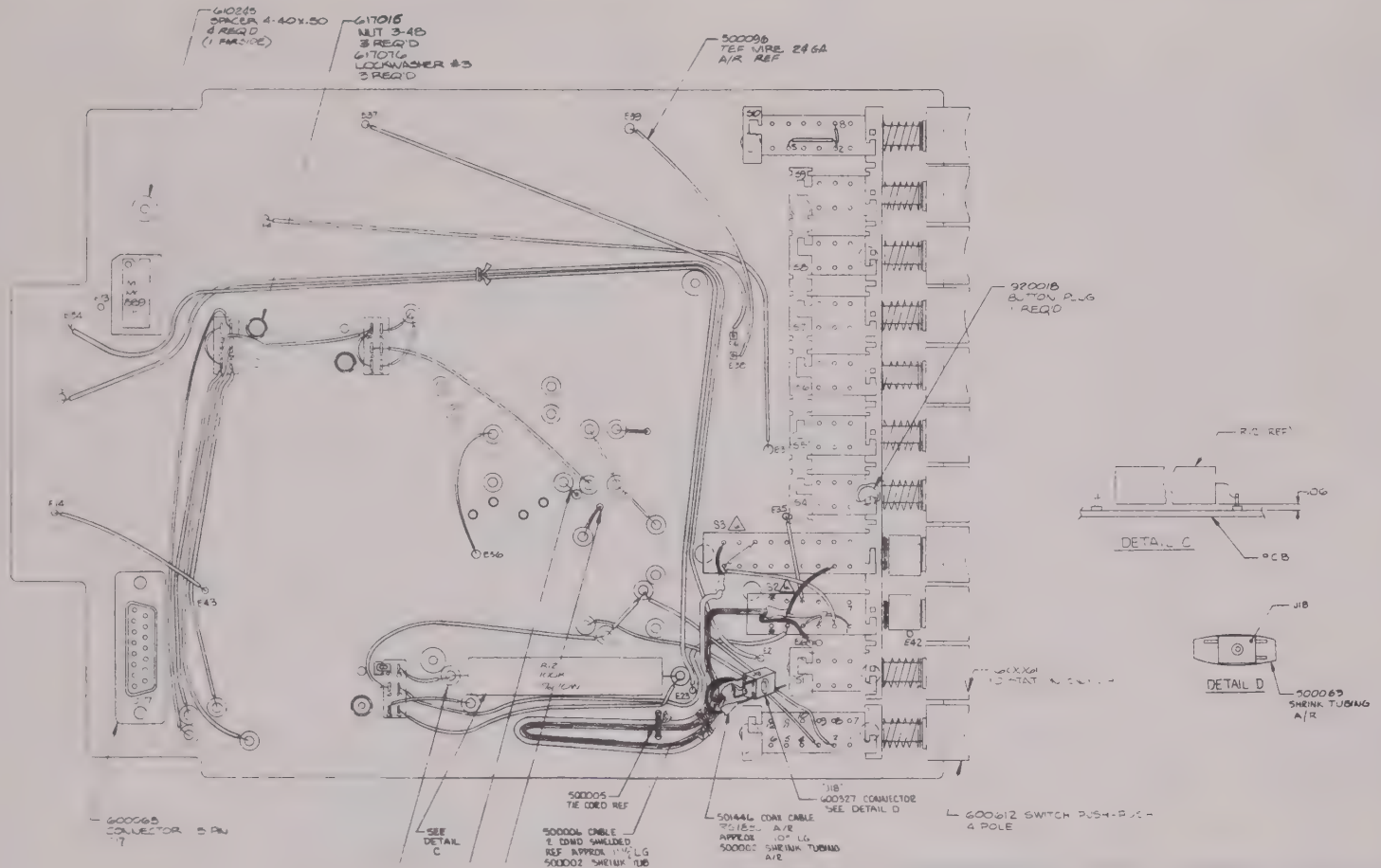
SECTION 6

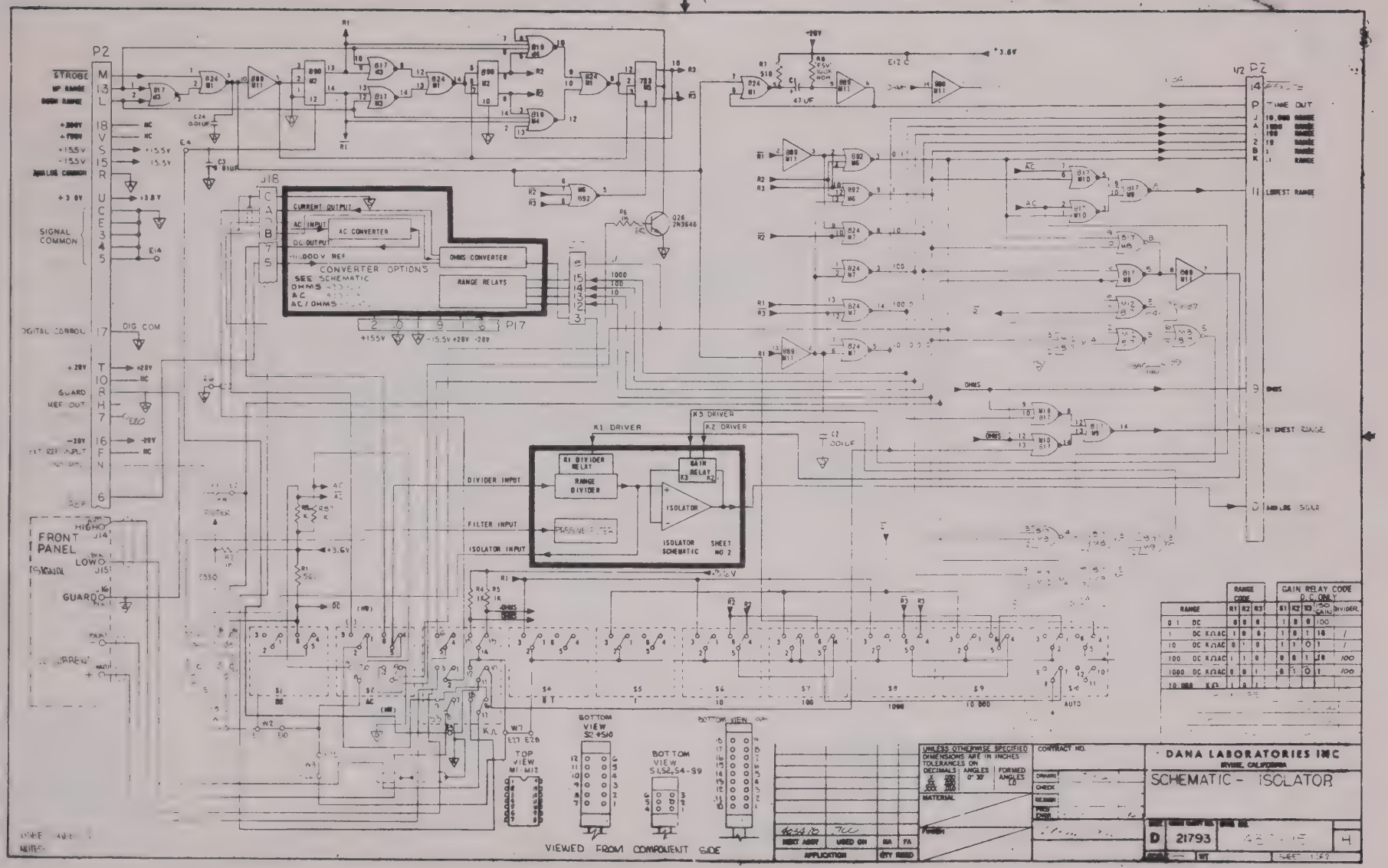
DRAWINGS

6.1 DRAWINGS.

Isolator Assembly, Module 700	403478
Isolator Schematic, Module 700	430975
Isolator Assembly, Module 703	403481
Isolator Schematic, Module 703	430971
AC Accessory, Model 51	403499
PCB Assembly, Model 51	403476
Schematic, Model 51	430968
Ohms Accessory, Model 61	403500
PCB Assembly, Model 61	403475
Schematic, Model 61	430969
AC/Ohms Accessory, Model 71	403501
PCB Assembly, Model 71	403477
Schematic, Model 71	430970
PCB Assembly, Program, Module 703	403482
Schematic, Program, Module 703	430972


SEE DETAIL B
615002 SCREW 4-40 x ½ PPH
617077 #4 LOCK WASH
617102 #4 FLAT WASH
610245 SPACER (REF)
920460 IC SOCKET 14 PIN 2 PLACES
MOUNT C11 AS CLOSE AS POSSIBLE TO GROUND PLANE.
500058 24GA WIRE BLK A/R
500007 SHRINK TUBING A/R
500096 TEF WIRE 24GA A/R
453027 COVER ENVIR
920006 TRANS PAD 2 REQD
500030 TEFLON TERM. 5 REQD.
500243 MOUL TEF TERM 20 REQD 2 HARDWARE REQ
500229 TERMINAL 4 REQD
500096 W.R.E. 24GA 2 PLACES
SOURCE
INSTALLATION OF FET TOP VIEW
INSTALLATION OF FET BOTTOM VIEW
SIDE A
SIDE B
DRAIN
GATE
SOURCE
P.C. BOARD
OTHER END
NOTES: UNLESS OTHERWISE SPECIFIED
REMOVE METAL CAPS FROM REAR OF SOCKET
SCHEMATIC REFERENCE 403678
ALL RESISTORS MAY BE ¼ WATT
ASSY PROCESSES & PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS
FET MARKED A SOURCE OF SIDE A TO POINT A
FET MARKED B SOURCE OF SIDE A TO POINT A
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS X.030 XX.020 XXX.010
ANGLES 0 30' FORMED 1°0'
HOLE DIAMETERS .004 .001
DIMENSIONS AND TOLERANCES PER USAS Y14.5
MATERIAL
FINISH
NEXT DWG
USED ON
APPLICATION
QTY REQD
DANA LABORATORIES INC
IRVINE CALIFORNIA
-55Y I/O BOARD
ISOLATOR "00
SIZE D
CODE IDENT NO. 21793
DWG NO 403678
REV R
SCALE 2:1
SHEET 1 OF 2


610245
SPACER 4-40 x .50
4 REQ'D
(1 PER SIDE)
617016
NUT 3-48
3 REQ'D
617016
LOCKWASHER #3
3 REQ'D
500098
TEF WIRE 24 GA
A/R REF
92001B
BUTTON PLG
1 REQ'D
R/C REF
.06
DETAIL C
.CB
J1B
DETAIL D
500063
SHRINK TUBING
A/R
600063
CONNECTOR 5 PIN
SEE DETAIL C
500005
TIE CORD REF
500006 CABLE
2 COND SHIELDED
REF APPROX 11½" LG
500002 SHRINK TUB
REF A/R
501446 COAX CABLE
RG 188 A/U A/R
APPROX 10" LG
500002 SHRINK TUBING
A/R
600527 CONNECTOR
SEE DETAIL D
600612 SWITCH PUSH-BUTTON
4 POLE
BASE GND REF
500057
WIRE 24 GA
A/R
MOUNT LONG STEM OF TEFLON
STANDOFF THIS SIDE
2 PLACES REF
SEE SHEET 1
NOTES UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES AND
INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS
X .030
XX .020
XXX .010
ANGLES
0° 30'
FORMED
1 0°
HOLE
DIAMETERS
+ .004
- .001
DIMENSIONS AND TOLERANCES
PER USAS Y14.15
MATERIAL
FINISH
NEXT DWG
USED ON
APPLICATION
QTY REQD
DANA
DANA LABORATORIES INC
IRVINE, CALIFORNIA
ASSY PC BOARD
ISOLATOR
SIZE
D
CODE IDENT NO.
21793
DWG NO
403478
REV
R
SCALE 2:1
SHEET 2 OF 5



RANGE	RANGE CODE R1	R2	R3	GAIN RELAY CODE D.C. ONLY K1	K2	K3	GAIN	DIVIDER
0.1 DC	0	0	0	1	0	0	100	
1 DC & AC	1	0	0	1	0	1	10	/
10 DC & AC	0	1	0	1	1	0	1	/
100 DC & AC	1	1	0	0	0	1	10	100
1000 DC & AC	0	0	1	0	1	0	1	100
10 000 KΩ								

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS / ANGLES / FORMED ANGLES

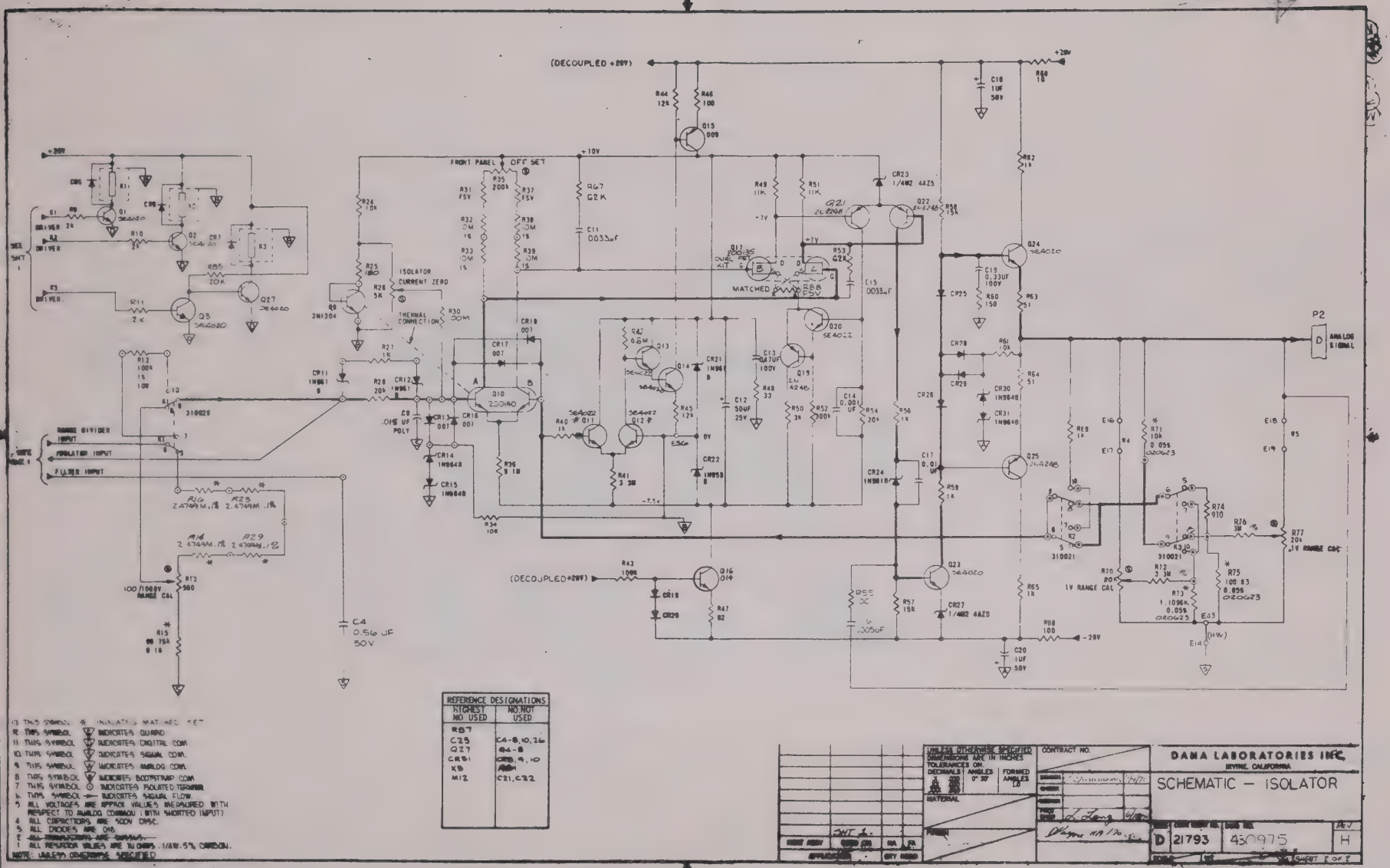
CONTRACT NO.

DANA LABORATORIES INC
IRVINE, CALIFORNIA

SCHEMATIC - ISOLATOR

D 21793 4

SHEET 1 OF 2



REFERENCE DESIGNATIONS	
HIGHEST NO USED	NO NOT USED
R87	
C29	C4-8,10,26
Q27	Q4-8
CR81	CR9,10
K3	
M12	C21,C32

13 THIS SYMBOL * INDICATES MATCHED SET
12 THIS SYMBOL INDICATES GUARD
11 THIS SYMBOL INDICATES DIGITAL COM
10 THIS SYMBOL INDICATES SIGNAL COM.
9 THIS SYMBOL INDICATES ANALOG COM.
8 THIS SYMBOL INDICATES BOOTSTRAP COM
7 THIS SYMBOL INDICATES ISOLATED TERMINAL
6 THIS SYMBOL INDICATES SIGNAL FLOW.
5 ALL VOLTAGES ARE APPROX VALUES, UNBALANCED WITH RESPECT TO ANALOG COMMON (WITH SHORTED INPUT)
4 ALL CAPACITORS ARE 500V DISC.
3 ALL DIODES ARE 1N6
2 ALL TRANSISTORS ARE 2N4250
1 ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5% CARBON.
NOTE: UNLESS OTHERWISE SPECIFIED

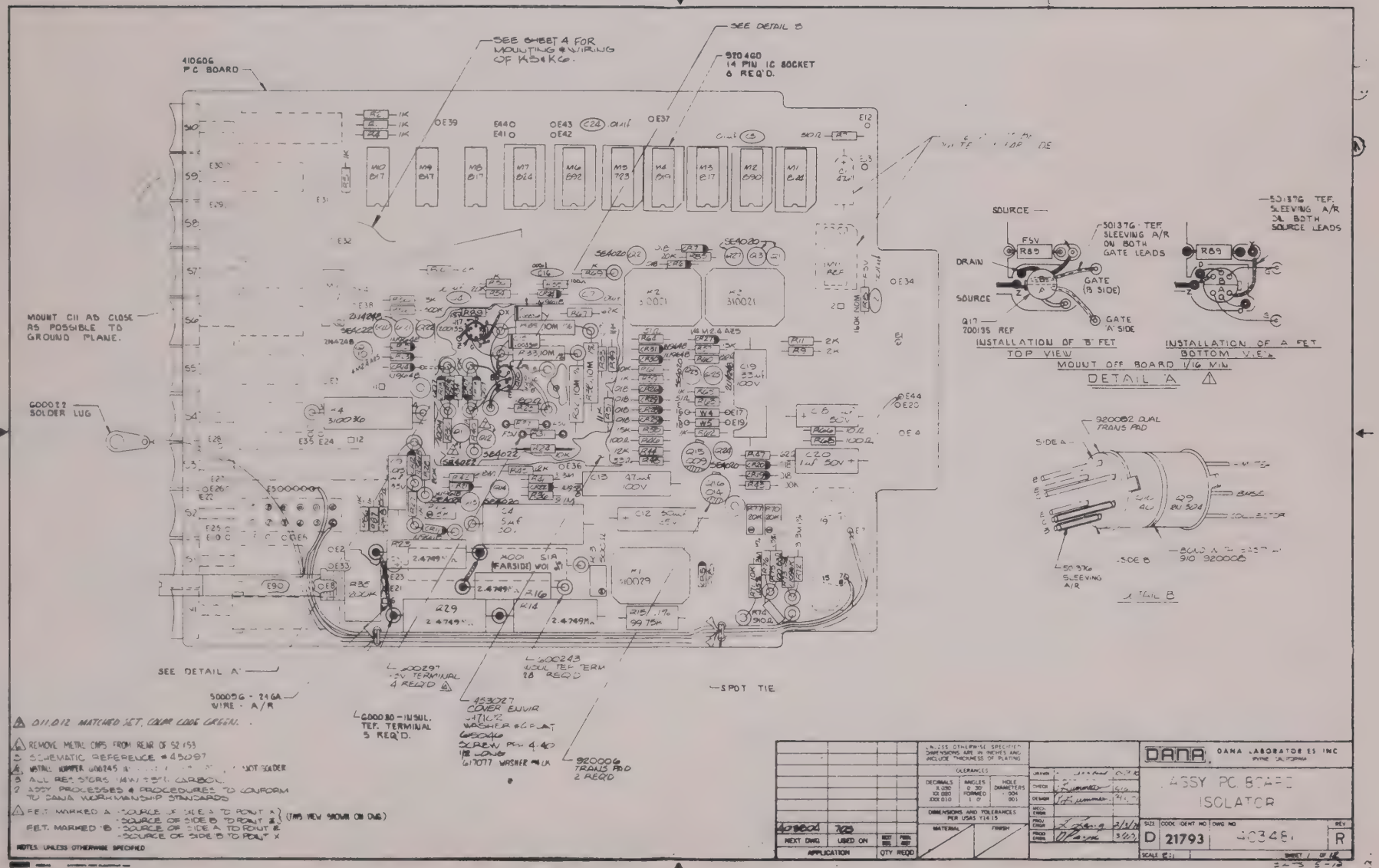
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS ± ANGLES 0° 30' FORMED ANGLES ±2°
MATERIAL
FINISH
CONTRACT NO.
DRAWN 1/4/71
CHECKED
ENGINEER
PROJ. ENGR
APPROVED
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
QTY REQD

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – ISOLATOR

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430975	H

SCALE | WT | SHEET 2 OF 2


SEE SHEET 4 FOR MOUNTING & WIRING OF K5 & K6.
SEE DETAIL B
920400 14 PIN IC SOCKET 8 REQ'D.
410606 P.C. BOARD
MOUNT C11 AS CLOSE AS POSSIBLE TO GROUND PLANE.
600082 SOLDER LUG
SEE DETAIL A
500056 - 24GA WIRE - A/R
600297 .3" TERMINAL 4 REQ'D
600243 LOOL TEF. TERM 28 REQ'D
600080 - INSUL. TEF. TERMINAL 5 REQ'D.
453027 COVER ENVIR
471672 WASHER #6 FLAT
650046 SCREW PAN 4-40 1/8" LONG
617077 WASHER #4 LK
920006 TRANS PAD 2 REQ'D
SPOT TIE
SOURCE
DRAIN
GATE (B SIDE)
GATE A SIDE
Q17 700135 REF
501376 TEF. SLEEVING A/R ON BOTH GATE LEADS
501376 TEF. SLEEVING A/R ON BOTH SOURCE LEADS
INSTALLATION OF B FET TOP VIEW
INSTALLATION OF A FET BOTTOM VIEW
MOUNT OFF BOARD 1/16 MIN
DETAIL A
920082 QUAL TRANS PAD
SIDE A
SIDE B
BASE
COLLECTOR
910 920006
501376 SLEEVING A/R
DETAIL B

⚠ D11, D12 MATCHED SET, COLOR CODE GREEN.

⚠ REMOVE METAL CHIPS FROM REAR OF 52153

2 SCHEMATIC REFERENCE # 45097

⚠ INSTALL JUMPER 600245 IN [illegible] NOT SOLDER

3 ALL RESISTORS (1/4W ±2%) CARBON.

4 ASSY PROCESSES & PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS

⚠ FET MARKED A "SOURCE OF SIDE A TO POINT A" "SOURCE OF SIDE B TO POINT B" (THIS VIEW SHOWN ON DWG)
FET MARKED "B" "SOURCE OF SIDE A TO POINT B" "SOURCE OF SIDE B TO POINT X"

NOTES: UNLESS OTHERWISE SPECIFIED

410606	705				
NEXT DWG	USED ON	NEXT ASSY	PRIN ASSY		
APPLICATION		QTY REQD			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

CLEARANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .250	0 30'	.004
.XX .020	FORMED	.001
.XXX .010	1 0°	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN
CHECK
DESIGN
MECH ENGR
PROJ ENGR
PROD ENGR

DANA LABORATORIES INC
IRVINE, CALIFORNIA

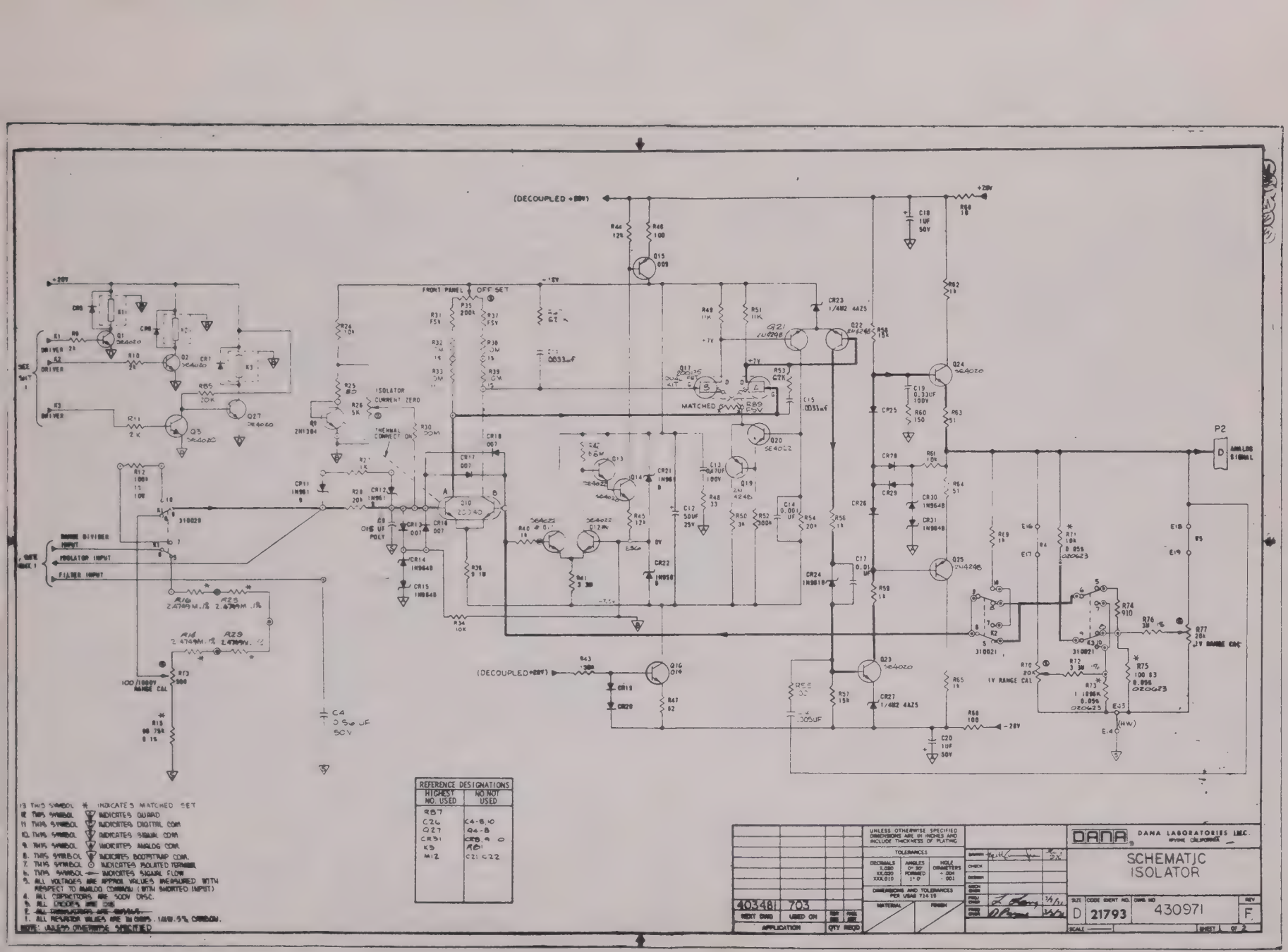
ASSY PC BOARD ISOLATOR

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	410481	R

SCALE 2:1

SHEET 1 OF 4

SEE A SIDE



REFERENCE DESIGNATIONS	
HIGHEST NO. USED	NO NOT USED
R87	
C26	K4-8,10
Q27	Q4-8
CR91	CR8,9 0
K5	A01
MI2	C21 C22

13. THIS SYMBOL * INDICATES MATCHED SET
12. THIS SYMBOL ⬡ INDICATES QUAD
11. THIS SYMBOL ⬡ INDICATES DIGITAL COM
10. THIS SYMBOL ⬡ INDICATES SIGNAL COM
9. THIS SYMBOL ⬡ INDICATES ANALOG COM.
8. THIS SYMBOL ⬡ INDICATES BOOTSTRAP COM.
7. THIS SYMBOL ○ INDICATES ISOLATED TERMINAL
6. THIS SYMBOL → INDICATES SIGNAL FLOW
5. ALL VOLTAGES ARE APPROX VALUES (MEASURED WITH RESPECT TO ANALOG COMMON WITH SHORTED INPUT)
4. ALL CAPACITORS ARE 50DV DISC.
3. ALL DIODES ARE 1N4
2. ALL TRANSISTORS ARE 2N4249
1. ALL RESISTOR VALUES ARE 1M OHMS, 1/4W, 5% CARBON.

NOTE: UNLESS OTHERWISE SPECIFIED

403481	703				
NEXT ASSY	USED ON				
APPLICATION				QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.030	0° 30'	+ .004
XX.020	FORMED	- .001
XXX.010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

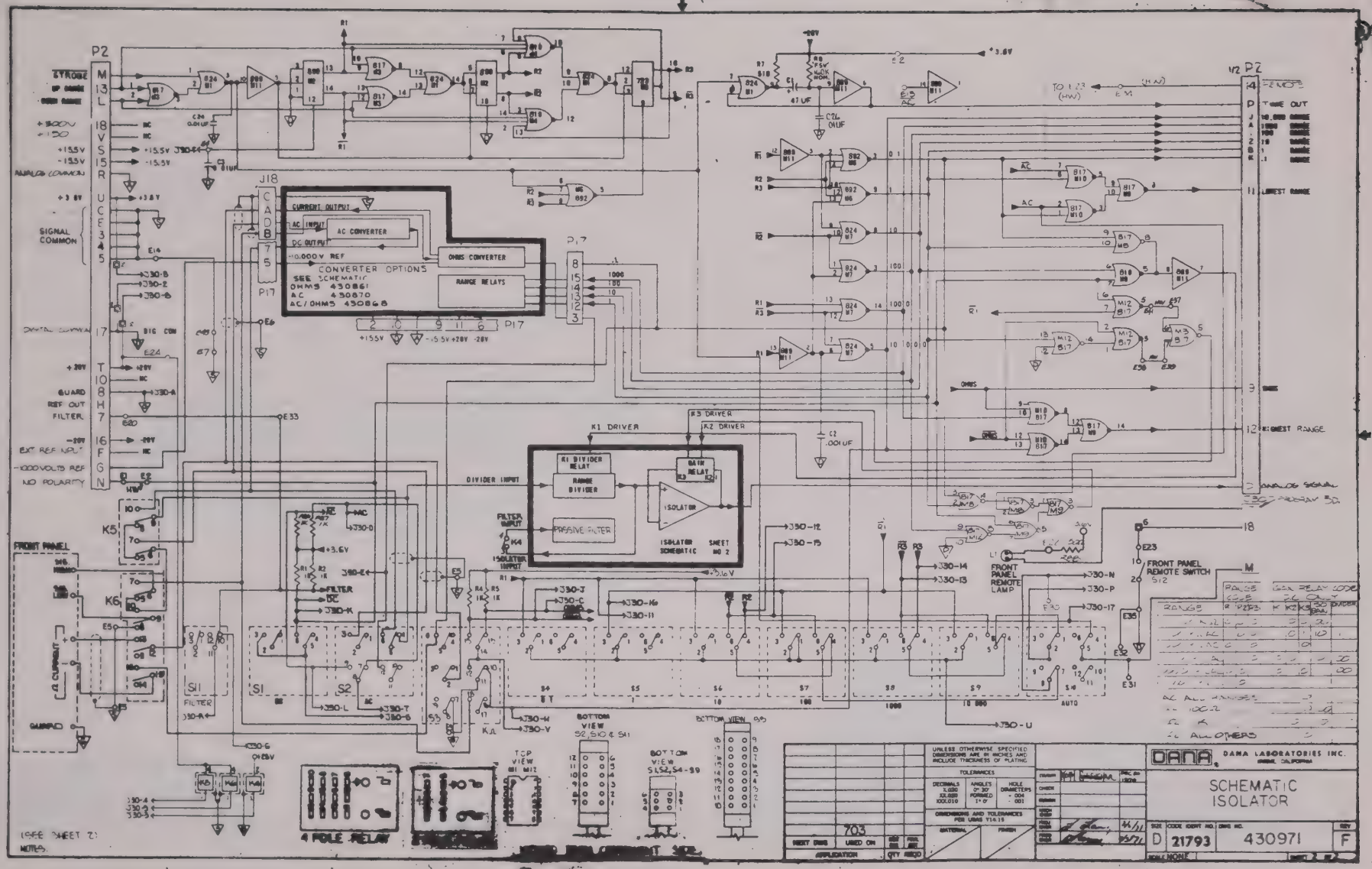
DRAWN 7/1/71
CHECK
ENGR
MFG APPR
PROJ ENGR

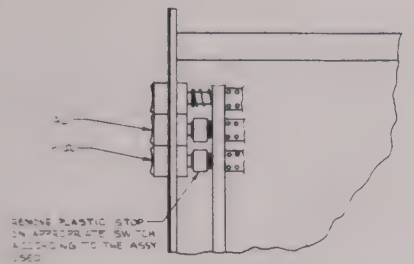
DANA LABORATORIES INC.
IRVINE CALIFORNIA

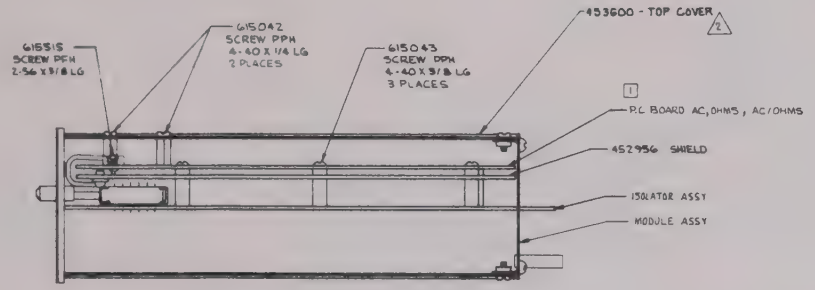
SCHEMATIC
ISOLATOR

SIZE	CODE IDENT NO.	DWG NO	REV
D	21793	430971	F

SCALE — SHEET 1 OF 2


P2
J18
P17
CURRENT OUTPUT
AC INPUT
AC CONVERTER
DC OUTPUT
+10.000V REF
OHMS CONVERTER
RANGE RELAYS
CONVERTER OPTIONS
SEE SCHEMATIC
OHMS 430861
AC 430870
AC/OHMS 430868
K1 DRIVER
K2 DRIVER
K3 DRIVER
K1 DIVIDER RELAY
RANGE DIVIDER
GAIN RELAY
ISOLATOR
PASSIVE FILTER
DIVIDER INPUT
FILTER INPUT
ISOLATOR INPUT
ISOLATOR SCHEMATIC SHEET NO 2
FRONT PANEL REMOTE LAMP
FRONT PANEL REMOTE SWITCH S12
TO 123 (HW)
TO 123 (HW)
4 POLE RELAY
BOTTOM VIEW S2, S10 & SA1
BOTTOM VIEW S1, S2, S4-S9
TOP VIEW
SEE SHEET 2
NOTES:
DANA LABORATORIES INC.
SCHEMATIC
ISOLATOR
D
21793
430971
F
NONE





SIDE EXTRUSION REMOVED FOR CLARITY

	403477	P.C. BOARD ASSY AC/OHMS	403501
1	403475	P.C. BOARD ASSY OHMS	403500
1	403476	P.C. BOARD ASSY AC	403499
REQD	ASSY NO	DESCRIPTION	ACCESSORY NO

⚠ REMOVE EXISTING TOP COVER (P/N 452476) & RETURN TO STOCK. REPLACE WITH 453600 TOP COVER S.S.

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTE: UNLESS OTHERWISE SPECIFIED

403498	700	1	1
NEXT ASSY	USED ON	QTY REQD	ASSY QTY
APPLICATION			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIMENSIONS
.XXX ±.010	± 30'	+.004 −.001
.XXXX ±.0020	FRACTIONS ± 1/64	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN | CHECKED | ENGR APPR | MFG APPR | QUALITY | COMMENTS

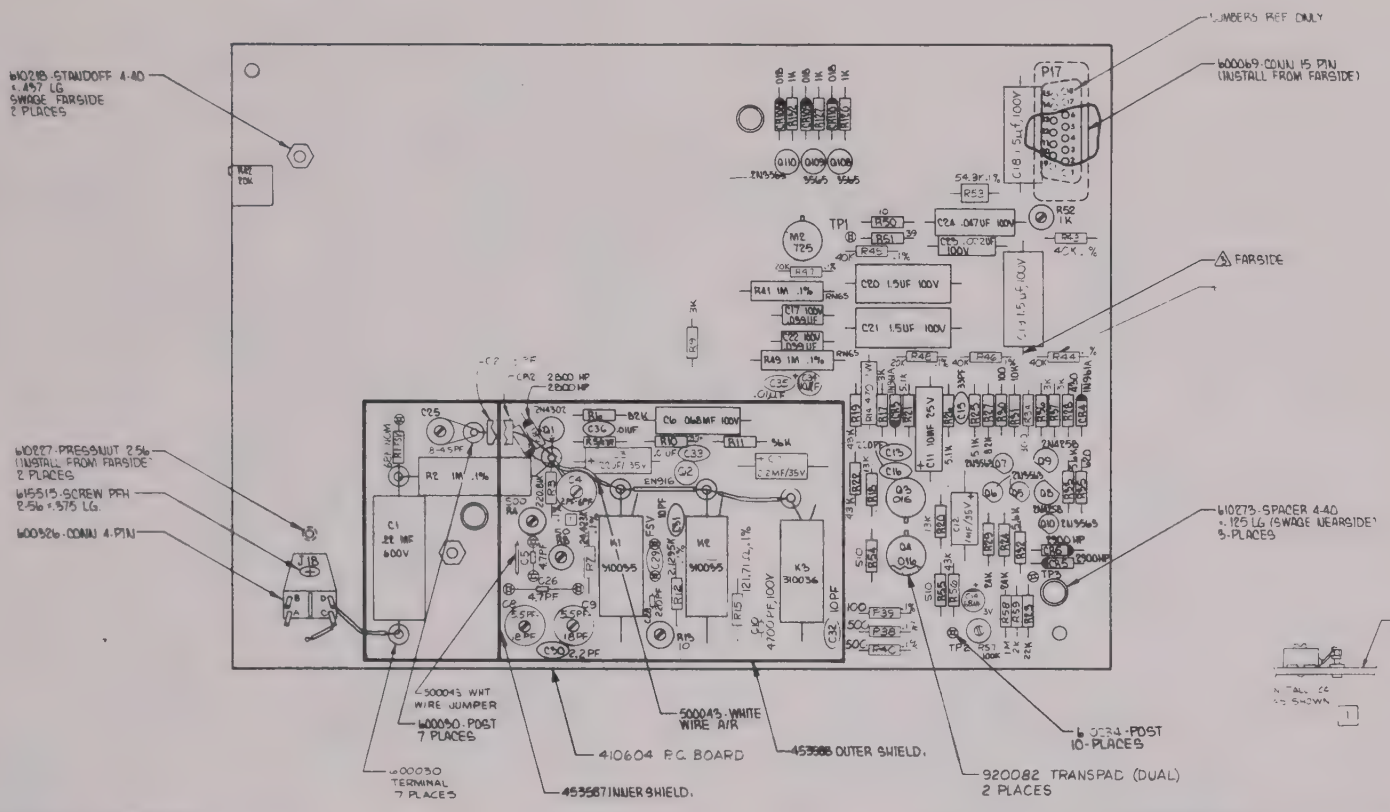
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY- AC / OHMS
ACCESSORY

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403499, 403500, 403501	C

SCALE 1/1 | SHEET 1 OF 4

SHEETS 2, 3, AND 4 ARE A SIDE



⚠ THE FOLLOWING TO BE MATCHED PAIRS
(R43-R44)(R45-R46)

5 ELEVATE R14 ABOVE P.C. BOARD 1/16" APPROX

4 ALL RESISTOR VALUES ARE IN OHMS, 1/2W, ±5% CARBON.

⚠ ALL COMPONENT LEADS MUST BE CUT SO THAT NONE EXTEND BEYOND .062 (1/16) FROM THE CIRCUIT SIDE OF BOARD (FARSIDE).

2 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

1 SCHEMATIC REF: 430968

NOTES UNLESS OTHERWISE SPECIFIED

403499	703	1	1
403477	700	1	1
NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING.

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0 30'	.004
XX .010	FORMED	.001
XXX .010	1 0	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN	M.C. & M.J. Kaay	8-3-70
CHECK		
DESIGN	P. Hammon	9/14/70
MECH ENGR		
PROJ ENGR	J. Kang	9/14/70
PROD ENGR	D.F.S.	11-11-70

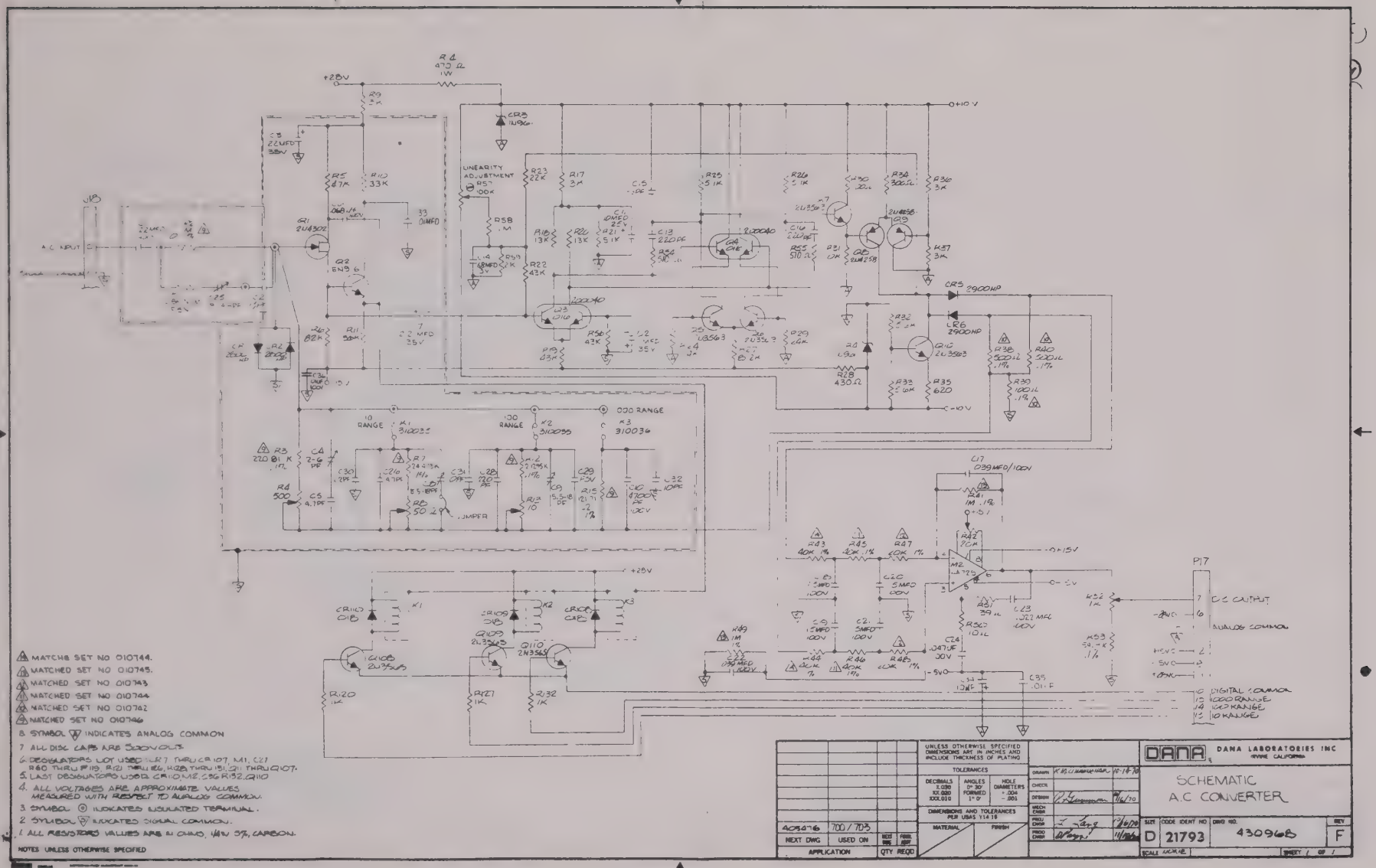
DANA DANA LABORATORIES INC.
IRVINE, CALIFORNIA

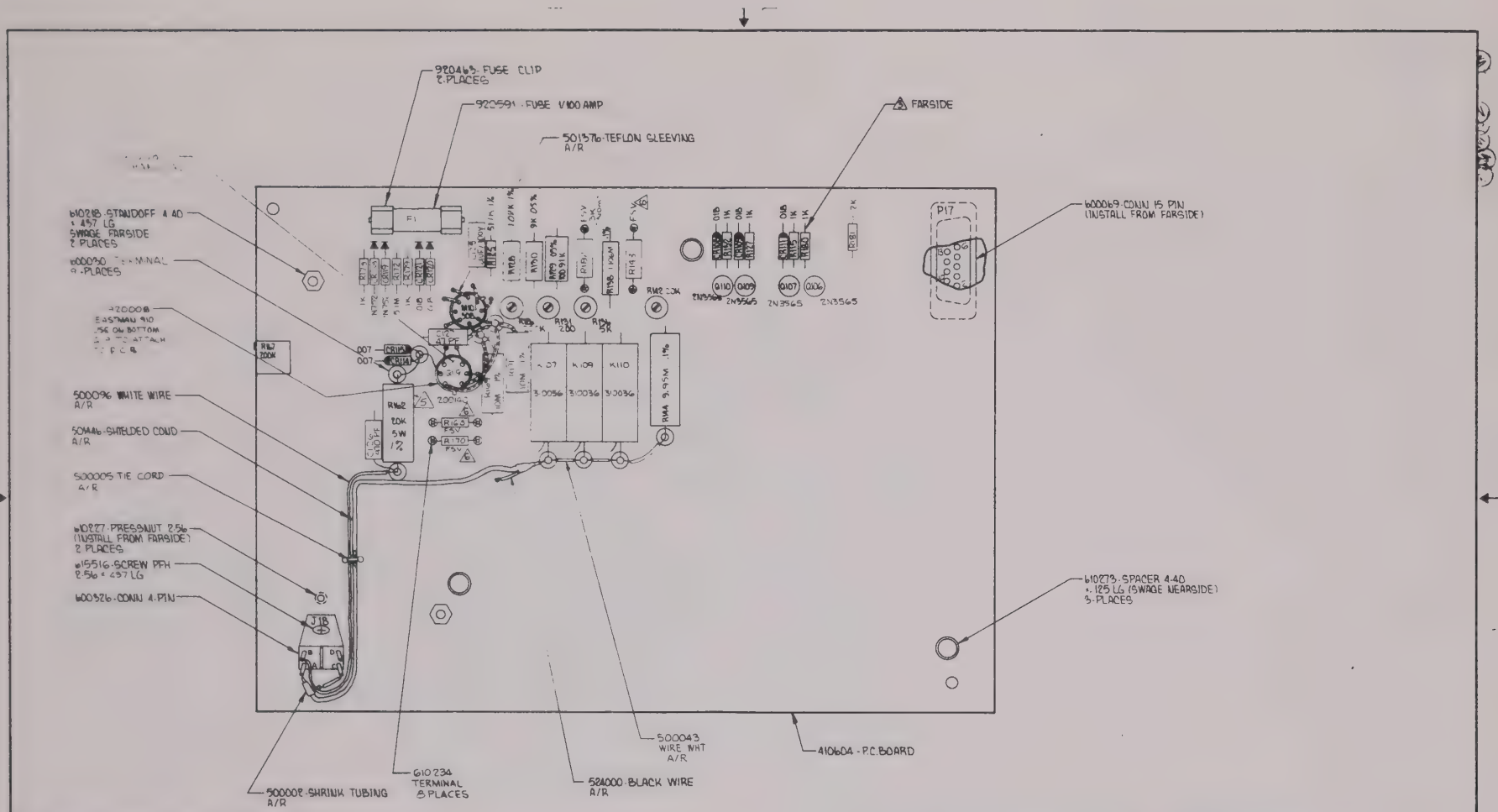
P.C. BOARD ASSY. AC CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403476	F

SCALE 2/1 SHEET 1 OF 6

SHEETS 2 THRU 6 ARE B SIZE


+28V
R4 470Ω 1W
+10V
-10V
+5V
-5V
+15V
-15V
LINEARITY ADJUSTMENT R57 100K
10 RANGE K1 310035
100 RANGE K2 310035
1000 RANGE K3 310036
A.C INPUT
P17
D/C OUTPUT
ANALOG COMMON
DIGITAL COMMON
1000 RANGE
100 RANGE
10 RANGE
MATCHED SET NO 010744.
MATCHED SET NO 010745.
MATCHED SET NO 010743
MATCHED SET NO 010744
MATCHED SET NO 010742
MATCHED SET NO 010746
8. SYMBOL ▽ INDICATES ANALOG COMMON
7. ALL DISC CAPS ARE 500VOLTS
6. REGULATORS NOT USED: CR107 THRU CR110, M1, C21 R60 THRU R119, R121 THRU R126, R128 THRU R131, R211 THRU R107.
5. LAST DESIGNATORS USED: CR110, M2, C86 R132, Q110
4. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
3. SYMBOL ⊖ INDICATES INSULATED TERMINAL.
2. SYMBOL ▽ INDICATES SIGNAL COMMON.
1. ALL RESISTORS VALUES ARE IN OHMS, 1/4W 5%, CARBON.
NOTES UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS .X ±.030 .XX ±.020 .XXX ±.010
ANGLES 0° 30' FORMED 1° 0'
HOLE DIAMETERS +.004 -.001
DIMENSIONS AND TOLERANCES PER USAS Y14.5
MATERIAL
FINISH
DRAWN K.N.U. MARQUARDT 10-18-70
CHECK
DESIGN P.H. Zimmerman 11/6/70
WELD CHECK
PROJ ENGR J. Lang 11/6/70
PROD ENGR D. Rogers 11/6/70
DANA DANA LABORATORIES INC IRVINE CALIFORNIA
SCHEMATIC A.C CONVERTER
SIZE D
CODE IDENT NO 21793
DWG NO. 430968
REV F
SCALE NONE
SHEET 1 OF 1
A04876 700 / 703
NEXT DWG USED ON
APPLICATION
NEXT ASSY
FINISH ASSY
QTY REQD


920465-FUSE CLIP 2 PLACES
920591-FUSE 1/100 AMP
501376-TEFLON SLEEVING A/R
FARSIDE
610218-STANDOFF 4-40 x .437 LG SWAGE FARSIDE 2 PLACES
600090-TERMINAL 9 PLACES
920008 EASTMAN 910 USE ON BOTTOM TO ATTACH TO P.C.B.
500096 WHITE WIRE A/R
500446-SHIELDED COND A/R
500005 TIE CORD A/R
610227-PRESSNUT 2-56 (INSTALL FROM FARSIDE) 2 PLACES
615516-SCREW PFH 2-56 x .437 LG
600526-CONN 4 PIN
600069-CONN 15 PIN (INSTALL FROM FARSIDE)
610273-SPACER 4-40 x .125 LG (SWAGE NEARSIDE) 3-PLACES
500008-SHRINK TUBING A/R
610234 TERMINAL 8 PLACES
500043 WIRE WHT A/R
520000-BLACK WIRE A/R
410604-P.C.BOARD

⚠ RESISTORS R143, 168 & R170 ARE FSV; INSTALL 600845 JUSUL JUMPER DURING INITIAL ASSY.

⚠ ELEVATE R162 ABOVE P.C. BOARD, 1/16 APPROX.

4. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ±5% CARBON.

⚠ ALL COMPONENT LEADS MUST BE CUT SO THAT NONE EXTEND BEYOND .062 (1/16) FROM THE CIRCUIT SIDE OF BOARD (FARSIDE).

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

1. SCHEMATIC REF: 410969

NOTES: UNLESS OTHERWISE SPECIFIED

403500	703		
403500	700		
NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
.X ±.020	± 30' FORMED 1 D°	SOM ± .001
.XX ±.010		
.XXX ±.010		

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

DRAWN	M.L. M. Kaag	8-570
CHECK		
DESIGN		9/14/70
MECH ENGR		
PROJ ENGR		9/14/70
APPD ENGR		9/14/70

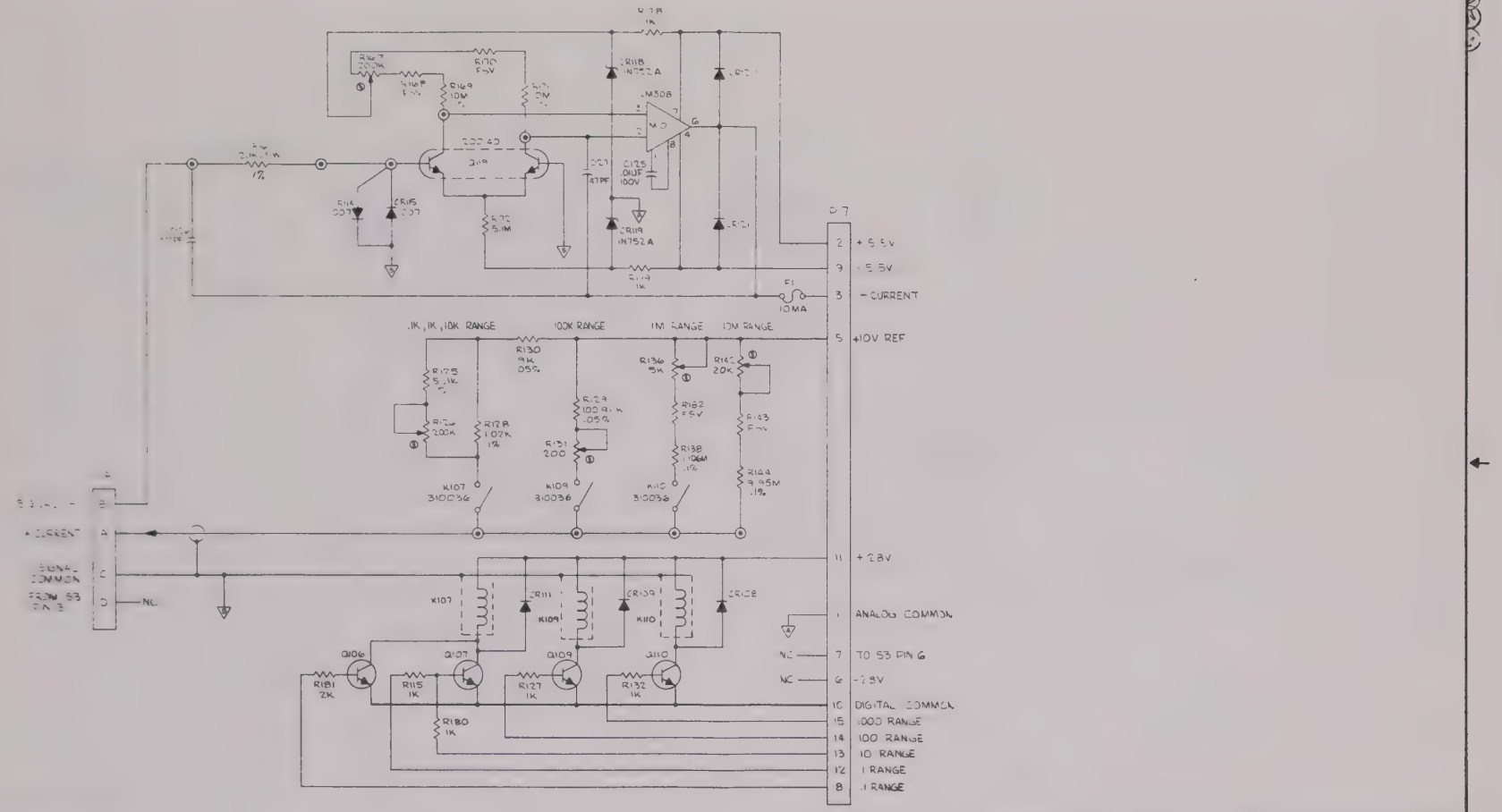
DANA — DANA LABORATORIES INC. IRVINE, CALIFORNIA

P.C.BOARD ASSY. OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	409475	K

SCALE 2/1 SHEET 1 OF 4

SHEETS 2 THRU ARE A SIZE B/M



7. ALL CAPACITORS ARE 500V DISC.
6. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON
5. THIS SYMBOL ◉ INDICATES INSULATED TERMINAL.
4. THIS SYMBOL ▽ INDICATES SIGNAL COMMON.
3. ALL DIODES TO BE 1N48.
2. ALL TRANSISTORS TO BE 2N3565
1. ALL RESISTORS ARE IN OHMS, ½W ±5%, CARBON.

403425	703	REF	REF
403475	700	REF	REF
NEXT DWG	USED ON		
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS .X ±.010, .XX ±.005, .XXX ±.003
ANGLES 0° 30' FORMED 1° 0'
HOLE DIAMETERS +.004 −.001
DIMENSIONS AND TOLERANCES PER USAS Y14.5

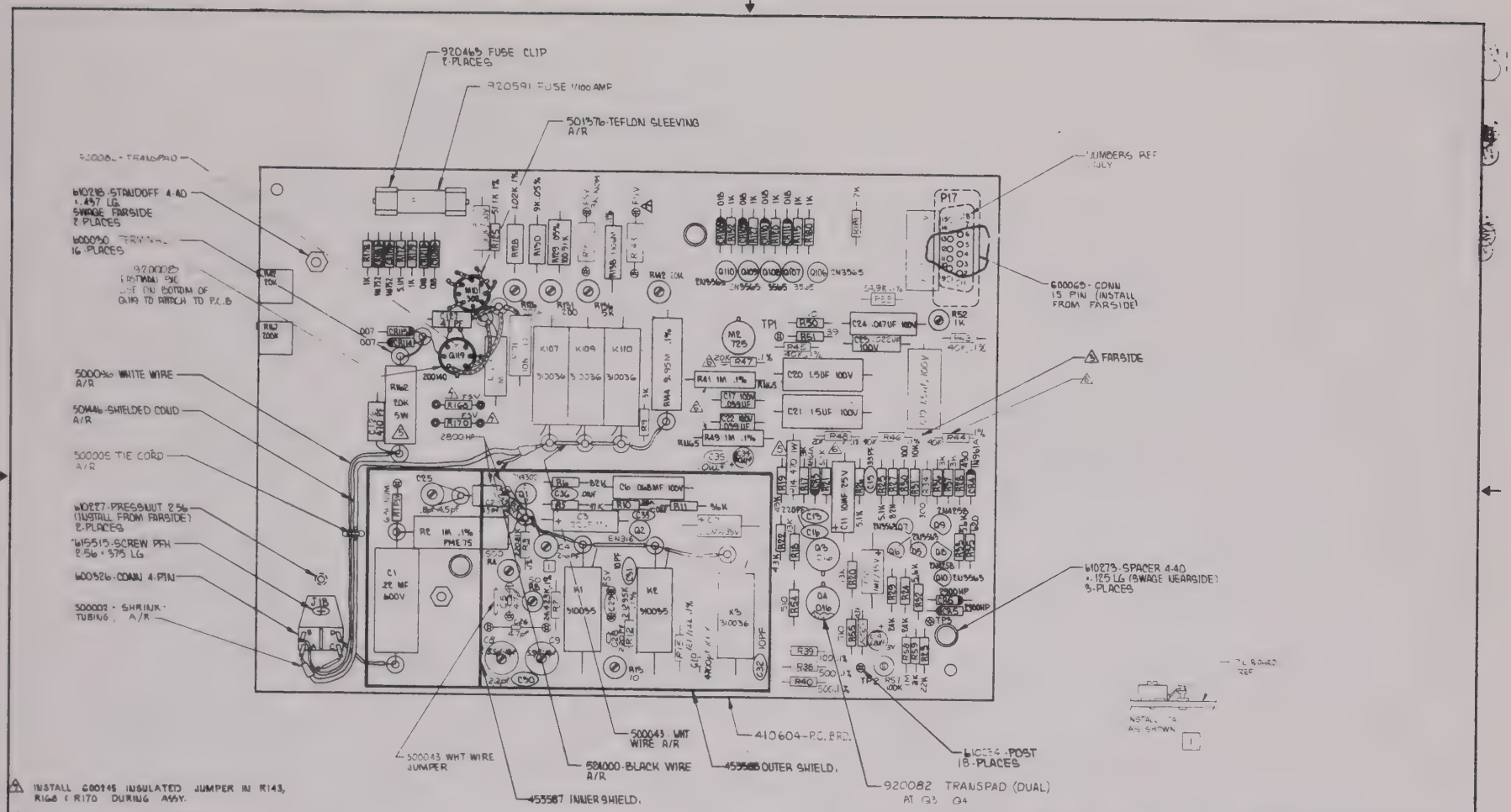
DRAWN 12/12/62
CHECK
DESIGN 12/21/62
MECH ENGR
ENGR APPR 1/10/63
QUAL APPR 1/10/63

DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC - OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430969	F

SCALE —



⚠ INSTALL 600245 INSULATED JUMPER IN R143, R168 & R170 DURING ASSY.

⚠ THE FOLLOWING RESISTOR MATCHED PAIRS (R43-R44) (R45-R46)

⚠ ELEVATE R144 & R162 ABOVE P.C. BOARD, 1/16" APPROX

4. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ±5% CARBON.

⚠ ALL COMPONENT LEADS MUST BE CUT SO THAT NONE EXTEND BEYOND .062 (1/16D) FROM THE CIRCUIT SIDE OF BOARD (FARSIDE).

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

1. SCHEMATIC REF: 430970.

NOTES: UNLESS OTHERWISE SPECIFIED

403501	703	1	1
403501	700	1	1
NEXT DWG	USED ON	ASSY QTY	FINAL ASSY QTY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.030	0 30'	.004
XX.020	FORMED	-.001
XXX.010	1 0°	

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL FINISH

DRAWN	Mike McKaig	8-5-70
CHECK		
DESIGN		11/4/
ENGR APPR		
PROJ ENGR		11/4/70
PROD ENGR		11/6/70

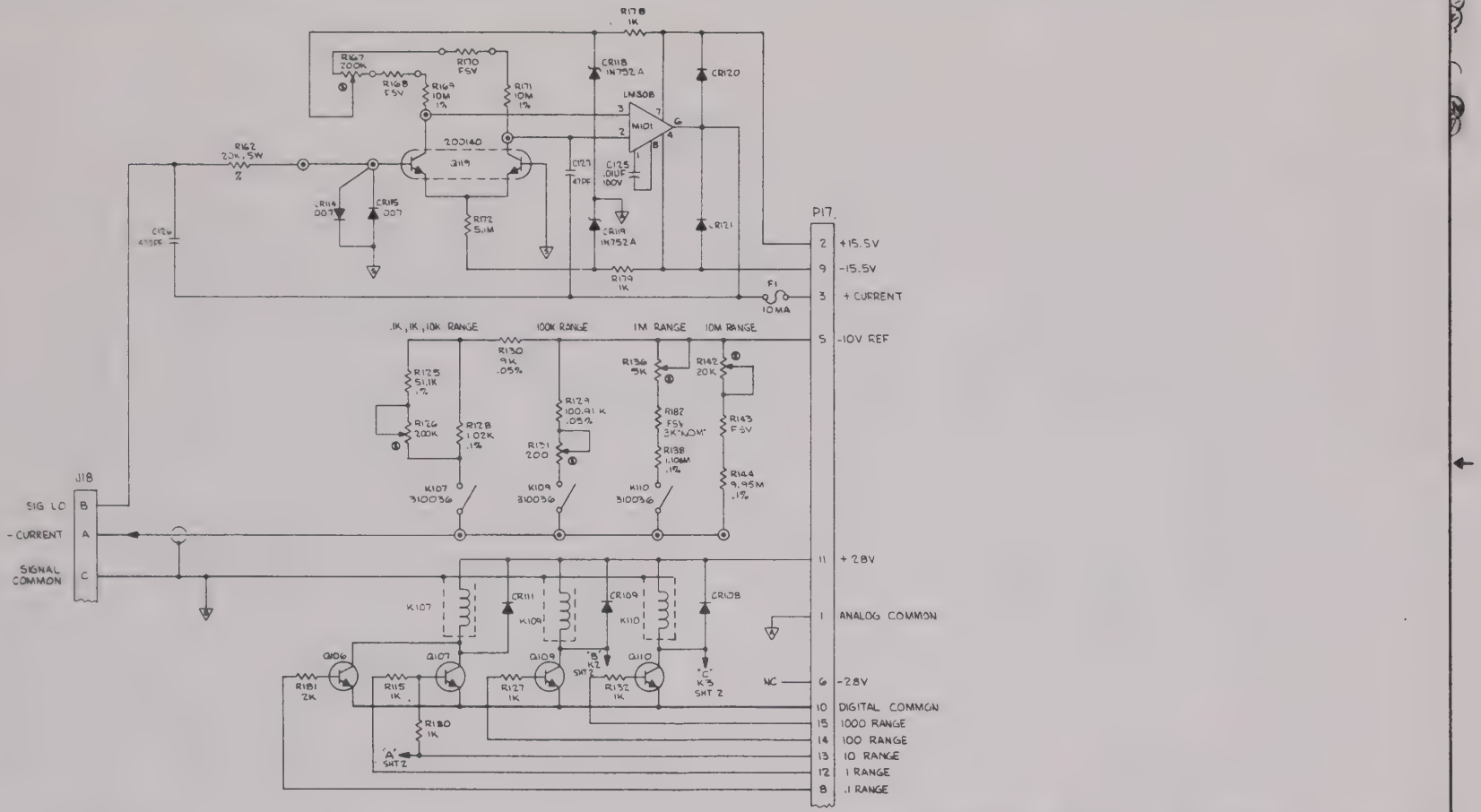
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA

P.C. BOARD ASSY.
AC & OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403477	P

SCALE 2/1 SHEET OF

SHEETS 2 THRU ARE A SIZE 8.5"



7. ALL CAPACITORS ARE 500V DISC.
6. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON
5. THIS SYMBOL ⊕ INDICATES INSULATED TERMINAL.
4. THIS SYMBOL ▽ INDICATES SIGNAL COMMON.
3. ALL DIODES TO BE 1N8.
2. ALL TRANSISTORS TO BE 2N3563.
1. ALL RESISTORS ARE IN OHMS, ¼W 5%, CARBON.

UNLESS OTHERWISE NOTED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

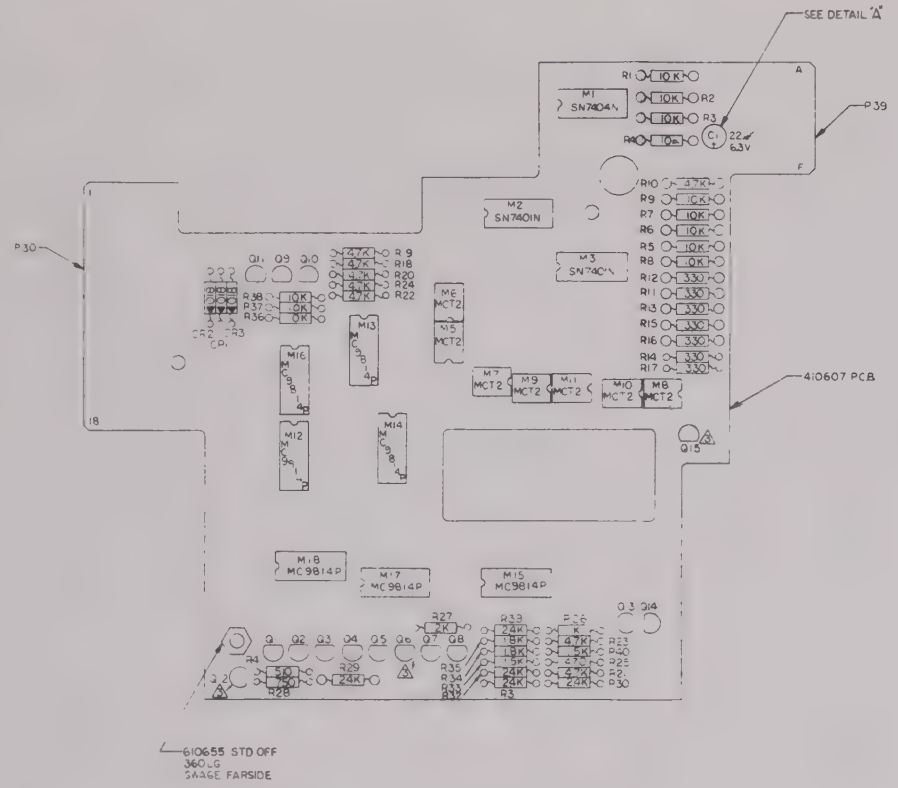
403477	703	REF	REF
403477	700	USE	REF
NEXT ASSY	USED ON		
APPLICATION		QTY REQD	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - AC / OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430970	K

SCALE | SHEET 1 OF 2



DETAIL "A"

6. ALL DIODES ARE 018
5. Q1, 5, 7, 8, 9, 10 ARE 2N3641
4. Q9, 10, 11 ARE 2N3565
3. Q6, 12, 15 ARE P/N 200200
2. REF SCHEM NO. 430972
1. ASSY PROCESSES/PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS

NOTES: UNLESS OTHERWISE SPECIFIED

403504	703			
NEXT DWG	USED ON			
APPLICATION			QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X .030	0° 30'	+ .004
XX .010	FORMED 1° 0'	- .001
XXX .010		

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

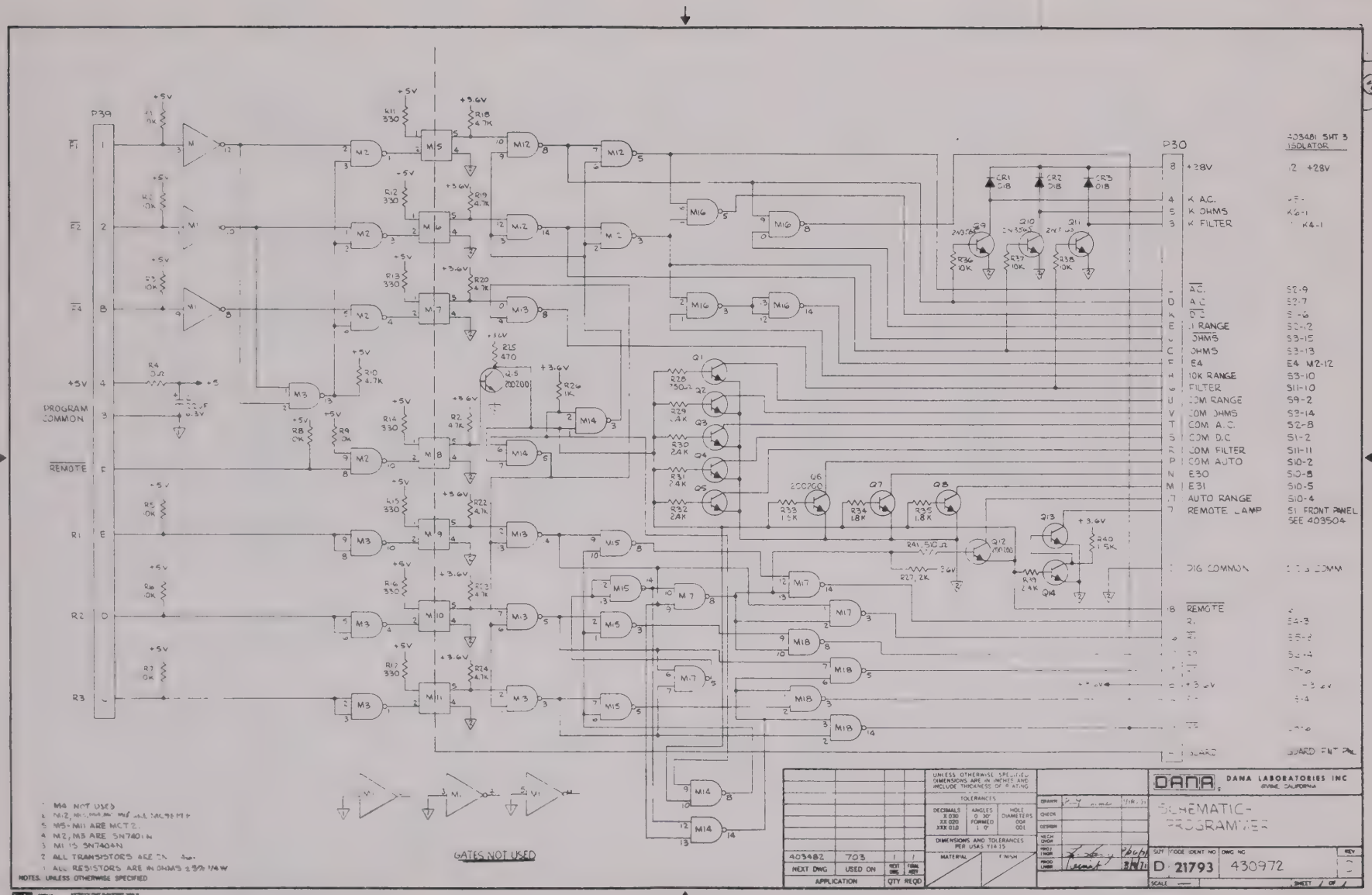
DRAWN	P. Gunnerson	1/15/71
CHECK		
DESIGN	P. Gunnerson	1/15/71
MECH ENGR		
PROJ ENGR	[illegible]	2/4/71
PROD ENGR	R. Rinehart	2/5/71

DANA LABORATORIES INC.
IRVINE CALIFORNIA

ASSY-PCB
PROGRAMMER

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	403482	D

SCALE 2/1 SHEET 1 OF 2


P39
P30
PROGRAM COMMON
REMOTE
+5V
+3.6V
GATES NOT USED
SCHEMATIC-PROGRAMMER
DANA LABORATORIES INC
IRVINE, CALIFORNIA
D 21793
430972
403482
703
NEXT DWG
USED ON
APPLICATION
NOTES: UNLESS OTHERWISE SPECIFIED

PARTS LIST

ASSEMBLY 403478 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION						
CR05	211083	DIODE	SILICO		018		DANA	211083
CR06	211083	DIODE	SILICO		018		DANA	211083
CR07	211083	DIODE	SILICO		018		DANA	211083
CR11	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR12	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR13	211236	DIODE	SILICO		007		DANA	211236
CR14	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR15	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR16	211236	DIODE	SILICO		007		DANA	211236
CR17	211236	DIODE	SILICO		007		DANA	211236
CR18	211236	DIODE	SILICO		007		DANA	211236
CR19	211083	DIODE	SILICO		018		DANA	211083
CR20	211083	DIODE	SILICO		018		DANA	211083
CR21	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR22	220012	DIODE	SILICO	ZENER	1N958B		MOTOROLA	1N958B
CR23	221177	DIODE	SILICO	ZENER		1/4 W	MOTOROLA	M.2.4A25
CR24	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR25	211083	DIODE	SILICO		018		DANA	211083
CR26	211083	DIODE	SILICO		018		DANA	211083
CR27	221177	DIODE	SILICO	ZENER		1/4 W	MOTOROLA	M.2.4A25
CR28	211083	DIODE	SILICO		018		DANA	211083
CR29	211083	DIODE	SILICO		018		DANA	211083
CR30	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR31	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
C01	110086	CAP	TANTA	47 MFD	10 V	10%	KEMET	K47C6K
C02	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C03	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C04	120271	CAP	POLY	.5 MFD	50 V	5%	IMB	PV2A504J
C09	120135	CAP	POLYS	.015 MFD	33 V	10%	MIAL	611.3S
C11	120001	CAP	MYLAR	.0033 MFD	100 V	10%	CDE	WMF1D33
C12	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50
C13	120019	CAP	MYLAR	.47 MFD	100 V	10%	CDE	WMF1P47
C14	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C15	120001	CAP	MYLAR	.0033 MFD	100 V	10%	CDE	WMF1D33
C16	101645	CAP	CERAM	.005 MFD	1000 V	20%	ERIE	811-000-X5R0-502K
C17	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10

PARTS LIST

ASSEMBLY 403478 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION						
C18	110040	CAP	ELECT	1 MFD	50 V	20%	DUCATI	1-50
C19	120185	CAP	MYLAR	.33 MFD	100 V	10%	CD	WMF1F33
C20	110040	CAP	ELECT	1 MFD	50 V	20%	DUCATI	1-50
C24	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
J17	600063	CONN	15 S				CINCH	DA15S2
J18	600327	CONN	3 S 1 PIN				WINCHESTER	JF3S-1P-ACD
K01	310029	RELAY	24VDC 1550Ω				AM ZETTLR	~~AZ420-[illegible]~~ AZ420-467-20
K02	310021	RELAY	DC	2 PDT	24VDC	2500Ω	ALLIED	~~AZ42056105~~ AZ20-56
K03	310021	RELAY	DC	2 PDT	24VDC	2500Ω	ALLIED	AZ42056105
M01	230019	INTEGRATED CIRCUIT		MC824P			MOTOROLA	MC824P
M02	230023	INTEGRATED CIRCUIT		MC890P			MOTOROLA	MC890P
M03	230018	INTEGRATED CIRCUIT		MC817P			MOTOROLA	MC817P
M04	230055	INTEGRATED CIRCUIT		MC819P			MOTOROLA	MC819P
M05	230015	INTEGRATED CIRCUIT		MC723P			MOTOROLA	MC723P
M06	230053	INTEGRATED CIRCUIT		MC892P			MOTOROLA	MC892P
M07	230019	INTEGRATED CIRCUIT		MC824P			MOTOROLA	MC824P
M08	230018	INTEGRATED CIRCUIT		MC817P			MOTOROLA	MC817P
M09	230018	INTEGRATED CIRCUIT		MC817P			MOTOROLA	MC817P
M10	230018	INTEGRATED CIRCUIT		MC817P			MOTOROLA	MC817P
M11	230022	INTEGRATED CIRCUIT		MC889P			MOTOROLA	MC889P
M12	230018	INTEGRATED CIRCUIT		MC817P			MOTOROLA	MC817P
Q01	200129	TRANS					FAIRCHILD	SE4020
Q02	200129	TRANS					FAIRCHILD	SE4020
Q03	200129	TRANS					FAIRCHILD	SE4020
Q09	201084	TRANS	GERMAN PNP	2N1304			TI	2N1304
Q10	200140	TRANS	DUAL	TYPE 140 NPN			DANA	200140
Q11	200205	TRANS					FAIRCHILD	SE4022
Q12	200205	TRANS					FAIRCHILD	SE4022
Q13	200136	TRANS					FAIRCHILD	SE4022
Q14	200129	TRANS					FAIRCHILD	SE4020
Q15	200052	TRANS	SILICO PNP	009			DANA	200052
Q16	200035	TRANS	SILICO NPN	014			DANA	200035
Q17	200135	FET	KIT				DANA	200135
Q19	200068	TRANS	SILICO PNP	2N4248			FAIRCHILD	2N4248
Q20	200136	TRANS					FAIRCHILD	SE4022

PARTS LIST

ASSEMBLY 403478 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION						
Q21	200088	TRANS SILICO PNP	2N4248				FAIRCHILD	2N4248
Q22	200088	TRANS SILICO PNP	2N4248				FAIRCHILD	2N4248
Q23	200129	TRANS					FAIRCHILD	SE4020
Q24	200129	TRANS					FAIRCHILD	SE4020
Q25	200088	TRANS SILICO PNP	2N4248				FAIRCHILD	2N4248
Q26	200037	TRANS SILICO NPN	2N3646				FAIRCHILD	2N3646
Q27	200129	TRANS					FAIRCHILD	SE4020
R01	000561	RES CARBON	560 OHM	5%	1/4 W		OHMITE	RC07GF561J
R02	000102	RES CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R04	000102	RES CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R05	000102	RES CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R06	000102	RES CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R07	000511	RES CARBON	510 OHM	5%	1/4 W		OHMITE	RC07GF511J
R08	000164	RES CARBON	160 K	5%	1/4 W		OHMITE	RC07GF164J
R09	000202	RES CARBON	2 K	5%	1/4 W		OHMITE	RC07GF202J
R10	000202	RES CARBON	2 K	5%	1/4 W		OHMITE	RC07GF202J
R11	000202	RES CARBON	2 K	5%	1/4 W		OHMITE	RC07GF202J
R12	030015	RES WW	100 K	1%	10 W		C-F	M-100
R13	040093	RES VARI	500 OHM				SPECTRO	50-3-1-501
R14	020621	RES SET					DANA	020621
R15	020621	RES SET					DANA	020621
R16	020621	RES SET					DANA	020621
R23	020621	RES SET					DANA	020621
R24	000103	RES CARBON	10 K	5%	1/4 W		OHMITE	RC07GF103J
R25	000181	RES CARBON	180 OHM	5%	1/4 W		OHMITE	RC07GF181J
R26	040109	RES VARI	5 K				SPECTROL	50-3
R27	000102	RES CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R28	000203	RES CARBON	20 K	5%	1/4 W		OHMITE	RC07GF203J
R29	020621	RES SET					DANA	020621
R30	000107	RES CARBON	100 M	5%	1/4 W		OHMITE	RC07GF107J
R31	600245	JUMPER					GETTIG	L-2007-1
R32	010648	RES METAL SET	10 MEG		.1%	T2	PME	70C
R33	010648	RES METAL SET	10 MEG		.1%	T2	PME	70C
R34	000103	RES CARBON	10 K	5%	1/4 W		OHMITE	RC07GF103J
R35	040134	RES VARI	200 K				CTS	134

PARTS LIST

ASSEMBLY 403476 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION								
R36	000915	RES	CARBON	910 K	5%	1/4 W		OHMITE	RC07GF915J
R37	000245	JUMPER						GETTIG	L-2007-1
R38	010648	RES	METAL SET	10 MEG		.1%	T2	PME	70C
R39	010648	RES	METAL SET	10 MEG		.1%	T2	PME	70C
R40	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R41	000335	RES	CARBON	3.3 M	5%	1/4 W		OHMITE	RC07GF335J
R42	000685	RES	CARBON	6.8 MEG	5%	1/4 W		OHMITE	RC07GF685J
R43	000104	RES	CARBON	100 K	5%	1/4 W		OHMITE	RC07GF104J
R44	000123	RES	CARBON	12 K	5%	1/4 W		OHMITE	RC07GF123J
R45	000123	RES	CARBON	12 K	5%	1/4 W		OHMITE	RC07GF123J
R46	000101	RES	CARBON	100 OHM	5%	1/4 W		OHMITE	RC07GF101J
R47	000620	RES	CARBON	62 OHM	5%	1/4 W		OHMITE	RC07GF620J
R48	000330	RES	CARBON	33 K	5%	1/4 W		OHMITE	RC07GF330J
R49	000113	RES	CARBON	11 K	5%	1/4 W		OHMITE	RC07GF113J
R50	000302	RES	CARBON	3 K	5%	1/4 W		OHMITE	RC07GF302J
R51	000113	RES	CARBON	11 K	5%	1/4 W		OHMITE	RC07GF113J
R52	000304	RES	CARBON	300 K	5%	1/4 W		OHMITE	RC07GF304J
R53	000623	RES	CARBON	62K	5%	1/4 W		OHMITE	RC07GF623J
R54	000203	RES	CARBON	20 K	5%	1/4 W		OHMITE	RC07GF203J
R55	000101	RES	CARBON	100 OHM	5%	1/4 W		OHMITE	RC07GF101J
R56	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R57	000153	RES	CARBON	15 K	5%	1/4 W		OHMITE	RC07GF153J
R58	000153	RES	CARBON	15 K	5%	1/4 W		OHMITE	RC07GF153J
R59	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R60	000151	RES	CARBON	150 OHM	5%	1/4 W		OHMITE	RC07GF151J
R61	000103	RES	CARBON	10 K	5%	1/4 W		OHMITE	RC07GF103J
R62	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R63	000510	RES	CARBON	51 OHM	5%	1/4 W		OHMITE	RC07GF510J
R64	000510	RES	CARBON	51 OHM	5%	1/4 W		OHMITE	RC07GF510J
R65	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R66	000100	RES	CARBON	10 OHM	5%	1/4 W		OHMITE	RC07GF100J
R67	000623	RES	CARBON	62K	5%	1/4 W		OHMITE	RC07GF623J
R68	000101	RES	CARBON	100 OHM	5%	1/4 W		OHMITE	RC07GF101J
R69	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J

PARTS LIST

ASSEMBLY 403476 - Model 700/703

REF. DESIG.	PART NO.	DESCRIPTION					
R70	040026	RES VARI	20 K	10%	1 W	TECHNC	35
R71	020623	RES WW SET				DANA	020623
R72	010701	RES METAL	3.3 MEG	1%		IRC	RN65D
R73	020623	RES WW SET				DANA	020623
R74	000911	RES CARBON	910 OHM	5%	1/4 W	OHMITE	RCO7GF911J
R75	020623	RES WW SET				DANA	020623
R76	010700	RES METAL	3 MEG	1%		IRC	RN65D
R77	040026	RES VARI	20 K	10%	1 W	TECHNC	35
R85	000203	RES CARBON	20 K	5%	1/4 W	OHMITE	RCO7GF203J
R86	000102	RES CARBON	1 K	5%	1/4 W	OHMITE	RCO7GF102J
R87	000102	RES CARBON	1 K	5%	1/4 W	OHMITE	RCO7GF102J
R88	200135	PET KIT				DANA	200135
S01	600611	SWITCH PUSHBUTTON				DANA	600611
S02	600611	SWITCH PUSHBUTTON				DANA	600611
S03	600611	SWITCH PUSHBUTTON				DANA	600611
S04	600611	SWITCH PUSHBUTTON				DANA	600611
S05	600611	SWITCH PUSHBUTTON				DANA	600611
S06	600611	SWITCH PUSHBUTTON				DANA	600611
S07	600611	SWITCH PUSHBUTTON				DANA	600611
S08	600611	SWITCH PUSHBUTTON				DANA	600611
S09	600611	SWITCH PUSHBUTTON				DANA	600611
S10	600611	SWITCH PUSHBUTTON				DANA	600611
S11	600612	SWITCH PUSH, 4-pole				DANA	600612
W01	600245	JUMPER				GETTIG	L-2007-1
W02	600245	JUMPER				GETTIG	L-2007-1
W03	600245	JUMPER				GETTIG	L-2007-1
W04	600245	JUMPER				GETTIG	L-2007-1
W05	600245	JUMPER				GETTIG	L-2007-1
W07	600245	JUMPER				GETTIG	L-2007-1
W08	600245	JUMPER				GETTIG	L-2007-1
W09	600245	JUMPER				GETTIG	L-2007-1

PARTS LIST

ASSEMBLY 403481 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
C01	110086	CAP	TANTA	47 MFD	10 V	10%	KEMET	K47C6K
C02	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C03	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH–S10
C04	120271	CAP	POLYS	.5 MFD	50 V	5%	IMB	PV2A504J
C09	120135	CAP	POLYS	.015 MFD	33 V	10%	MIAL	611.3S
C11	120001	CAP	MYLAR	.0033 MFD	100 V	10%	CDE	WMF1D33
C12	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50
C13	120019	CAP	MYLAR	.47 MFD	100 V	10%	CDE	WMF1P47
C14	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C15	120001	CAP	MYLAR	.0033 MFD	100 V	10%	CDE	WMF1D33
C16	101645	CAP	CERAM	.005 MFD	1000 V	20%	ERIE	811-000-X5R0-502K
C17	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C18	110040	CAP	ELECT	1 MFD	50 V	20%	DUCATI	1-50
C19	120185	CAP	MYLAR	.33 MFD	100 V	10%	CD	WMF1P33
C20	110040	CAP	ELECT	1 MFD	50 V	20%	DUCATI	1-50
C24	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C26	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
CR05	211083	DIODE	SILICO	018			DANA	211083
CR06	211083	DIODE	SILICO	018			DANA	211083
CR07	211083	DIODE	SILICO	018			DANA	211083
CR11	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR12	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR13	211236	DIODE	SILICO	007			DANA	211236
CR14	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR15	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR16	211236	DIODE	SILICO	007			DANA	211236
CR17	211236	DIODE	SILICO	007			DANA	211236
CR18	211236	DIODE	SILICO	007			DANA	211236
CR19	211083	DIODE	SILICO	018			DANA	211083
CR20	211083	DIODE	SILICO	018			DANA	211083
CR21	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR22	220012	DIODE	SILICO	ZENER	1N958B		MOTOROLA	1N958B
CR23	221177	DIODE	SILICO	ZENER		1/4W	MOTOROLA	M.2.4A25
CR24	220004	DIODE	SILICO	ZENER	1N961B		MOTOROLA	1N961B
CR25	211083	DIODE	SILICO	018			DANA	211083
CR26	211083	DIODE	SILICO	018			DANA	211083

PARTS LIST

ASSEMBLY 403481 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
CR27	221177	DIODE	SILICO	ZENER		1/4W	MOTOROLA	M.2.4A25
CR28	211083	DIODE	SILICO	018			DANA	211083
CR29	211083	DIODE	SILICO	018			DANA	211083
CR30	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
CR31	220016	DIODE	SILICO	ZENER	1N964B		MOTOROLA	1N964B
J17	600063	CONN	15 S				CINCH	DA15S2
J18	600327	CONN	3 S 1 PIN				WINCHESTER	JF3S-1P-ACD
K01	310029	RELAY					AM ZETTLR	AZ420-56
K02	310021	RELAY	DC	2 PDT	24 V		ALLIED	AZ42056105
K03	310021	RELAY	DC	2 PDT	24 V		ALLIED	AZ42056105
K04	310036	RELAY	REED				ELEC-TROL	R2096-3
K05	310044	RELAY	LOW LEVEL				PARELCO	R10-E-717-1
K06	310045	RELAY	LOW LEVEL				PARELCO	R10-E-718-1
M01	230019	INTEGRATED CIRCUIT			MC824P		MOTOROLA	MC824P
M02	230023	INTEGRATED CIRCUIT			MC890P		MOTOROLA	MC890P
M03	230018	INTEGRATED CIRCUIT			MC817P		MOTOROLA	MC817P
M04	230055	INTEGRATED CIRCUIT			MC819P		MOTOROLA	MC819P
M05	230015	INTEGRATED CIRCUIT			MC723P		MOTOROLA	MC723P
M06	230053	INTEGRATED CIRCUIT			MC892P		MOTOROLA	MC892P
M07	230019	INTEGRATED CIRCUIT			MC824P		MOTOROLA	MC824P
M08	230018	INTEGRATED CIRCUIT			MC817P		MOTOROLA	MC817P
M09	230018	INTEGRATED CIRCUIT			MC817P		MOTOROLA	MC817P
M10	230018	INTEGRATED CIRCUIT			MC817P		MOTOROLA	MC817P
M11	230022	INTEGRATED CIRCUIT			MC889P		MOTOROLA	MC889P
M12	230018	INTEGRATED CIRCUIT			MC817P		MOTOROLA	MC817P
Q01	200129	TRANS					FAIRCHILD	SE4020
Q02	200129	TRANS					FAIRCHILD	SE4020
Q03	200129	TRANS					FAIRCHILD	SE4020
Q09	201084	TRANS	GERMAN	PNP	2N1304		TI	2N1304
Q10	200140	TRANS	DUAL	TYPE 140 NPN			DANA	200140
Q11	200205	TRANS					FAIRCHILD	SE4022
Q12	200205	TRANS					FAIRCHILD	SE4022
Q13	200136	TRANS					FAIRCHILD	SE4022
Q14	200129	TRANS					FAIRCHILD	SE4020
Q15	200011	TRANS	SILICO	PNP 009			DANA	200011
Q16	200035	TRANS	SILICO	NPN 014			DANA	200035

PARTS LIST

ASSEMBLY 403481 -- Model 700/703

REF DES	PART NO.	DESCRIPTION					
Q17	200135	FET	KIT			DANA	200135
Q19	200022	TRANS	SILICO	PNP 012		DANA	200022
Q20	200136	TRANS				FAIRCHILD	SE4022
Q21	200022	TRANS	SILICO	PNP 012		DANA	200022
Q22	200022	TRANS	SILICO	PNP 012		DANA	200022
Q23	200129	TRANS				FAIRCHILD	SE4020
Q24	200129	TRANS				FAIRCHILD	SE4020
Q25	200022	TRANS	SILICO	PNP 012		DANA	200022
Q27	200129	TRANS				FAIRCHILD	SE4020
R01	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R02	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R04	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R05	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R07	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R09	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R10	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R11	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R12	030015	RES	WW	100 K	1% 10 W	C-F	M-100
R13	040093	RES	VARI	500 OHM		SPECTROL	50-3-1-501
R14	020621	RES	SET			DANA	020621
R15	020621	RES	SET			DANA	020621
R16	020621	RES	SET			DANA	020621
R23	020621	RES	SET			DANA	020621
R24	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R25	000181	RES	CARBON	180 OHM	5% 1/4W	OHMITE	RC07GF181J
R26	040109	RES	VARI	5 K		SPECTROL	50-3
R27	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R28	000203	RES	CARBON	20 K	5% 1/4W	OHMITE	RC07GF203J
R29	020621	RES	SET			DANA	020621
R30	000107	RES	CARBON	100 M	5% 1/4W	OHMITE	RC07GF107J
R32	010648	RES	METAL	SET 10 MEG	.1% T2	PME	70C
R33	010648	RES	METAL	SET 10 MEG	.1% T2	PME	70C
R34	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R35	040134	RES	VARI	200 K		CTS	134
R36	000915	RES	CARBON	910 K	5% 1/4W	OHMITE	RC07GF915J

PARTS LIST

ASSEMBLY 403481 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
R38	010648	RES	METAL	SET 10 MEG	.1%	T2	PME	70C
R39	010648	RES	METAL	SET 10 MEG	.1%	T2	PME	70C
R40	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R41	000335	RES	CARBON	3.3 M	5%	1/4W	OHMITE	RC07GF335J
R42	000685	RES	CARBON	6.8 MEG	5%	1/4W	OHMITE	RC07GF685J
R43	000104	RES	CARBON	100 K	5%	1/4W	OHMITE	RC07GF104J
R44	000123	RES	CARBON	12 K	5%	1/4W	OHMITE	RC07GF123J
R45	000123	RES	CARBON	12 K	5%	1/4W	OHMITE	RC07GF123J
R46	000101	RES	CARBON	100 OHM	5%	1/4W	OHMITE	RC07GF101J
R47	000620	RES	CARBON	62 OHM	5%	1/4W	OHMITE	RC07GF620J
R48	000330	RES	CARBON	33 K	5%	1/4W	OHMITE	RC07GF330J
R49	000113	RES	CARBON	11 K	5%	1/4W	OHMITE	RC07GF113J
R50	000302	RES	CARBON	3 K	5%	1/4W	OHMITE	RC07GF302J
R51	000113	RES	CARBON	11 K	5%	1/4W	OHMITE	RC07GF113J
R52	000304	RES	CARBON	300 K	5%	1/4W	OHMITE	RC07GF304J
R53	000623	RES	CARBON	62 K	5%	1/4W	OHMITE	RC07GF623J
R54	000203	RES	CARBON	20 K	5%	1/4W	OHMITE	RC07GF203J
R55	000101	RES	CARBON	100 OHM	5%	1/4W	OHMITE	RC07GF101J
R56	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R57	000153	RES	CARBON	15 K	5%	1/4W	OHMITE	RC07GF153J
R58	000153	RES	CARBON	15 K	5%	1/4W	OHMITE	RC07GF153J
R59	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R60	000151	RES	CARBON	150 OHM	5%	1/4W	OHMITE	RC07GF151J
R61	000103	RES	CARBON	10 K	5%	1/4W	OHMITE	RC07GF103J
R62	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R63	000510	RES	CARBON	510 OHM	5%	1/4W	OHMITE	RC07GF510J
R64	000510	RES	CARBON	510 OHM	5%	1/4W	OHMITE	RC07GF510J
R65	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R66	000100	RES	CARBON	10 OHM	5%	1/4W	OHMITE	RC07GF100J
R67	000623	RES	CARBON	62 K	5%	1/4W	OHMITE	RC07GF623J
R68	000101	RES	CARBON	100 OHM	5%	1/4W	OHMITE	RC07GF101J
R69	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R70	040026	RES	VARI	20 K	10%	1 W	TECHNO	35
R71	020623	RES	WW	SET	.05%		DANA	020623
R72	010701	RES	METAL	3.3 MEG	1%		IRC	RN65D

PARTS LIST

ASSEMBLY 403481 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
R73	020623	RES	WW	SET	.05%		DANA	020623
R74	000911	RES	CARBON	910 OHM	5%	1/4W	OHMITE	RC07GF911J
R75	020623	RES	WW	SET	.05%		DANA	020623
R76	010700	RES	METAL	3 MEG	1%		IRC	RN65D
R77	040026	RES	VARI	20 K	10%	1 W	TECHNO	35
R85	000203	RES	CARBON	20 K	5%	1/4W	OHMITE	RC07GF203J
R86	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R87	000102	RES	CARBON	1 K	5%	1/4W	OHMITE	RC07GF102J
R88	000151	RES	CARBON	150 OHM	5%	1/4W	OHMITE	RC07GF151J
R89	200135	FET	KIT				DANA	200135
S01	600611	SWITCH	PUSHBUTTON				DANA	600611
S02	600611	SWITCH	PUSHBUTTON				DANA	600611
S03	600611	SWITCH	PUSHBUTTON				DANA	600611
S04	600611	SWITCH	PUSHBUTTON				DANA	600611
S05	600611	SWITCH	PUSHBUTTON				DANA	600611
S06	600611	SWITCH	PUSHBUTTON				DANA	600611
S07	600611	SWITCH	PUSHBUTTON				DANA	600611
S08	600611	SWITCH	PUSHBUTTON				DANA	600611
S09	600611	SWITCH	PUSHBUTTON				DANA	600611
S10	600611	SWITCH	PUSHBUTTON				DANA	600611
S11	600612	SWITCH	PUSH	4-POLE			DANA	600612
W04	600245	JUMPER					GETTIG	L-2007-1
W05	600245	JUMPER					GETTIG	L-2007-1
R08	000164	RES	CARBON	160 K	5%	1/4W	OHMITE	RC07GF164J
R31	001737	RES	FSV		5%	1/4W	DANA	001737
R37	001737	RES	FSV		5%	1/4W	DANA	001737

PARTS LIST

ASSEMBLY 403476 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
C01	120007	CAP	MYLAR	.22 MFD	600 V	20%	ELEC CUBE	210B1F224
C02	100091	CAP	PORCE	1 PFD	500 V		VITRAMON	VY10CA1R5CA
C03	110002	CAP	TANTA	22 MFD	35 V	10%	KEMET	K22C35K
C04	130136	CAP	VARI	6 PFD	250 V		S-T	10S-TR1K0-06
C05	100087	CAP	CERAM	4.7 PFD	100 V	5%	ERIE	8101-A100-C0G-479J
C06	120011	CAP	POLYS	.068 MFD	100 V	10%	CDE	WMF1568
C07	110023	CAP	TANTA	22 MFD	35 V	10%	KEMET	K22C35K
C08	130137	CAP	VARI	18 PFD	250 V		S-T	10S-TR1K0-06
C09	130137	CAP	VARI	18 PFD	250 V		S-T	10S-TR1K0-06
C10	100089	CAP	CERAM	4700 PFD	100 V		ERIE	8141-17100-C0G-472J
C11	111262	CAP	ELECT	10 MFD	25 V	20%	SPRAGUE	TE1204
C12	110017	CAP	TANTA	1 MFD	35 V	10%	KEMET	K1C35K
C13	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C14	110154	CAP	TANTA	68 MFD	3 V	10%		K68E6
C15	100012	CAP	CERAM	33 PFD	500 V	10%	AEROVOX	TCD-N750
C16	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C17	120270	CAP	MYLAR	.039 MFD	100 V	5%	IMB	XA2B393J
C18	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J
C19	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J
C20	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J
C21	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J
C22	120270	CAP	MYLAR	.039 MFD	100 V	5%	IMB	XA2B393J
C23	121468	CAP	MYLAR	.022 MFD	100 V	10%	CDE	WMF1S22
C24	121093	CAP	MYLAR	.047 MFD	100 V	10%	CDE	WMF1S47
C25	130138	CAP	VARI	4.5 PFD	750 V		ERIE	5-61-013
C26	100087	CAP	CERAM	4.7 PFD	100 V	5%	ERIE	8101-A100-C0G-479J
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	SPRAGUE	TG-S10
C28	100088	CAP	CERAM	220 PFD	100 V	5%	ERIE	8121-17100-C0G-221J
C29	100090	CAP	CERAM	FSV			ERIE TECH	
C30	100050	CAP					SPRAGUE	10TCC-V22
C31	100006	CAP	CERAM	10 PFD	500 V	10%	AEROVOX	TCD-N750
C32	100006	CAP	CERAM	10 PFD	500 V	10%	AEROVOX	TCD-N750
C33	100023	CAP		.01 MFD	TYPE TTP		AEROVOX	100 V
C34	110151	CAP		10 MFD	25 V		ITT	43212-16210
C35	100023	CAP		.01 MFD	TYPE TTP		AEROVOX	100V
CR01	210015	DIODE		HP5082			HP	HP5082
CR02	210015	DIODE		HP5082			HP	HP5082

PARTS LIST

ASSEMBLY 403476 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
CR03	221254	DIODE	SILICO	ZENER	1N961A		MOTOROLA	1N961A
CR04	221254	DIODE	SILICO	ZENER	1N961A		MOTOROLA	1N961A
CR05	210032	DIODE					HP	5082-2900
CR06	210032	DIODE					HP	5082-2900
CR108	211083	DIODE	SILICO	018			DANA	211083
CR109	211083	DIODE	SILICO	018			DANA	211083
CR110	211083	DIODE	SILICO	018			DANA	211083
J18	600326	CONN					WINCHESTER	JP3P-1S-AC
K01	310035	RELAY	REED	SPST	24 V		AZTEC	LIA24-A1
K02	310035	RELAY	REED	SPST	24 V		AZTEC	LIA24-A1
K03	310036	RELAY	REED				ELEC-TROL	R2096-3
M02	230070	INTEGRATED CIRCUIT			UA725		FAIRCHILD	U5B7725393
P17	600069	CONN	15 P				CINCH	2311512121
Q01	200107	TRANS	N-CHAN	FIELD EFFECT			FAIRCHILD	2N4302
Q02	200163	TRANS		(SEE 200093)			FAIRCHILD	2N916
Q03	200040	TRANS	SILICO	NPN 016			DANA	200040
Q04	200040	TRANS	SILICO	NPN 016			DANA	200040
Q05	200095	TRANS		(SEE 200093)			FAIRCHILD	2N3563
Q06	200095	TRANS		(SEE 200093)			FAIRCHILD	2N3563
Q07	200095	TRANS		(SEE 200093)			FAIRCHILD	2N3563
Q08	200099	TRANS					TI	2N4258
Q09	200099	TRANS					TI	2N4258
Q10	200095	TRANS		(SEE 200093)			FAIRCHILD	2N3563
Q108	200043	TRANS	SILCIO	NPN	2N3565		FAIRCHILD	2N3565
Q109	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q110	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
R01	000683	RES	CARBON	68 K		5% 1/4W	OHMITE	RC07GF683J
R02	010746	RES	METAL	SET		1% 1 W	DANA	010746
R03	010746	RES	METAL	SET		.1%	DANA	010746
R04	040115	RES	VARI	500 K		10%	BECKMAN	62PR500
R05	000473	RES	CARBON	47 K		5% 1/4W	OHMITE	RC07GF473J
R06	000823	RES	CARBON	82 K		5% 1/4W	OHMITE	RC07GF823J
R07	010746	RES	METAL	SET		.1%	DANA	010746
R08	040114	RES	VARI	50 K		10%	BECKMAN	62PR50
R09	000302	RES	CARBON	3 K		5% 1/4W	OHMITE	RC07GF302J

PARTS LIST

ASSEMBLY 403476 – Model 700/703

REF DES	PART NO.	DESCRIPTION						
R10	000333	RES	CARBON	33 K	5%	1/4W	OHMITE	RC07GF333J
R11	000363	RES	CARBON	36 K	5%	1/4W	OHMITE	RC07GF363J
R12	010746	RES	METAL	SET	.1%		DANA	010746
R13	040183	POT		10 OHM			BECKMAN	62PR10
R14	001788	RES	CARBON	470 OHM	5%	1 W	OHMITE	RC20GF751J
R15	010746	RES	METAL	SET			DANA	010746
R17	000302	RES	CARBON	3 K	5%	1/4W	OHMITE	RC07GF302J
R18	000133	RES	CARBON	13 K	5%	1/4W	OHMITE	RC07GF133J
R19	000433	RES	CARBON	43 K	5%	1/4W	OHMITE	RC07GF433J
R20	000133	RES	CARBON	13 K	5%	1/4W	OHMITE	RC07GF133J
R21	000512	RES	CARBON	5.1 K	5%	1/4W	OHMITE	RC07GF512J
R22	000473	RES	CARBON	47 K	5%	1/4W	OHMITE	RC07GF473J
R23	000223	RES	CARBON	22 K	5%	1/4W	OHMITE	RC07GF223J
R24	000243	RES	CARBON	24 K	5%	1/4W	OHMITE	RC07GF243J
R25	000512	RES	CARBON	5.1 K	5%	1/4W	OHMITE	RC07GF512J
R26	000512	RES	CARBON	5.1 K	5%	1/4W	OHMITE	RC07GF512J
R27	000822	RES	CARBON	8.2 K	5%	1/4W	OHMITE	RC07GF822J
R28	000431	RES	CARBON	430 OHM	5%	1/4W	OHMITE	RC07GF431J
R29	000243	RES	CARBON	24 K	5%	1/4W	OHMITE	RC07GF243J
R30	000101	RES	CARBON	100 OHM	5%	1/4W	OHMITE	RC07GF101J
R31	000103	RES	CARBON	10 K	5%	1/4W	OHMITE	RC07GF103J
R32	000562	RES	CARBON	5.6 K	5%	1/4W	OHMITE	RC07GF562J
R33	000562	RES	CARBON	5.6 K	5%	1/4W	OHMITE	RC07GF562J
R34	000301	RES	CARBON	300 OHM	5%	1/4W	OHMITE	RC07GF301J
R35	000621	RES	CARBON	620 OHM	5%	1/4W	OHMITE	RC07GF621J
R36	000302	RES	CARBON	3 K	5%	1/4W	OHMITE	RC07GF302J
R37	000302	RES	CARBON	3 K	5%	1/4W	OHMITE	RC07GF302J
R38	010742	RES	METAL	SET	.1%		DANA	010742
R39	010742	RES	METAL	SET	.1%		DANA	010742
R40	010742	RES	METAL	SET	.1%		DANA	010742
R41	010745	RES	METAL	SET	.1%		DANA	010745
R42	040206	POT					IRC	750-10-20K
R43	010744	RES	METAL	SET	0.1%		DANA	010744
R44	010744	RES	METAL	SET	0.1%		DANA	010744
R45	010744	RES	METAL	SET	0.1%		DANA	010744

PARTS LIST

ASSEMBLY 403476 – Model 700/703

REF DES	PART NO.	DESCRIPTION					
R47	010743	RES	METAL	SET	.1%	DANA	010743
R48	010743	RES	METAL	SET	.1%	DANA	010743
R49	010745	RES	METAL	SET	.1%	DANA	010745
R50	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R51	000390	RES	CARBON	39 OHM	5% 1/4W	OHMITE	RC07GF390J
R52	040123	RES	VARI	1 K		BECKMAN	62PR1K
R53	020632	RES	WW	54.9 K	.1% 1/4W	JORDAN	J-90
R54	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R55	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J
R56	000433	RES	CARBON	43 K	5% 1/4W	OHMITE	RC07GF433J
R57	040088	RES	VARI	100 K	10%	BECKMAN	62PR100K
R58	000105	RES	CARBON	1 M	5% 1/4W	OHMITE	RC07GF105J
R59	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R120	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R127	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R132	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J

PARTS LIST

ASSEMBLY 403475 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION						
CR108	211083	DIODE	SILICO		018		DANA	211083
CR109	211083	DIODE	SILICO		018		DANA	211083
CR111	211083	DIODE	SILICO		018		DANA	211083
CR114	211236	DIODE	SILICO		007		DANA	211236
CR115	211236	DIODE	SILICO		007		DANA	211236
CR116	220019	DIODE	SILICO	ZENER	1N752A		MOTOROLA	1N752A
CR119	220019	DIODE	SILICO	ZENER	1N752A		MOTOROLA	1N752A
CR120	211083	DIODE	SILICO		018		DANA	211083
CR121	211083	DIODE	SILICO		018		DANA	211083
C125	121068	CAP	MYLAR	.01 MFD	100 V	10%	CDE	WMF1S1
C126	120093	CAP	POLYS	470 PFD	500 V	5%	CRL	CPR-470J
C127	120153	CAP	POLYS	47 PFD	125 V	10%	MIAL	611
J18	600326	CONN					WINCHESTER	JP3P-1S-AC
K107	310036	RELAY	REED				ELEC-TROL	R2096-3
K109	310036	RELAY	REED				ELEC-TROL	R2096-3
K110	310036	RELAY	REED				ELECOTROL	R2096-3
M101	230103	INTEGRATED CIRCUIT					NATIONAL	LM308
P17	600069	CONN	15 P				CINCH	2311512121
Q106	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q107	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q109	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q110	200043	TRANS	SILICO	NPN	2N3565		FAIRCHILD	2N3565
Q119	200140	TRANS	DUAL	TYPE	140 NPN		DANA	200140
R115	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R125	010073	RES	METAL	51.1 K	1%		IRC	RN60D
R126	040067	RES	VARI	200 K	10%	1/4 W	BECKMAN	62PR200K
R127	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R128	020624	RES		1.02 K	0.1%		JORDAN	J11
R129	020625	RES		100.91 K	0.05%		JORDAN	J11
R130	020626	RES		9 K	0.05%		JORDAN	J11
R131	040122	RES	VARI	200 OHM			BECKMAN	62PR200
R132	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R136	040097	RES	VARI	5 K	10%		BECKMAN	62PR5K
R138	010465	RES	METAL	1.106 MEG	.1%		PYROFILM	PME65-T9
R142	040046	RES	VARI	20 K	10%	1/4 W	BECKMAN	62PR20K
R143	001737	RES	FSV		5%	1/4 W	DANA	001737

PARTS LIST

ASSEMBLY 403475 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION							
R144	010466	RES		9.950	MEG	.1%		PYROFILM	PME70-T9
R162	020609	RES	WW	20	K	1%		C-F	M-30
R167	040207	POT		200	K			IRC	750-10-200K
R168	001737	RES	FSV			5%	1/4 W	DANA	001737
R169	010476	RES	METAL	10	MEG	1%	1/2 W	PYROFILM	PME70-T2
R170	001737	RES	FSV			5%	1/4 W	DANA	001737
R171	010476	RES	METAL	10	MEG	1%	1/2 W	PYROFILM	PME70-T2
R172	000515	RES	CARBON	5.1	M	5%	1/4 W	OHMITE	RC07GF515J
R178	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R179	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R180	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R181	000202	RES	CARBON	2	K	5%	1/4 W	OHMITE	RC07GF202J
R182	000302	RES	CARBON	3	K	5%	1/4 W	OHMITE	RC07GF302J

PARTS LIST

ASSEMBLY 403477 - Model 700/703

REF. DESIG.	PART NO.	DESCRIPTION						
CR01	210015	DIODE			HP5082		HP	HP5082
CR02	210015	DIODE			HP5082		HP	HP5082
CR03	221254	DIODE	SILICO	ZENER	1N961A		MOTOROLA	1N961A
CR04	221254	DIODE	SILICO	ZENER	1N961A		MOTOROLA	1N961A
CR05	210032	DIODE					HP	HP5082-2900
CR06	210032	DIODE					HP	HP5082-2900
CR108	211083	DIODE	SILICO		018		DANA	211083
CR109	211083	DIODE	SILICO		018		DANA	211083
CR110	211083	DIODE	SILICO		018		DANA	211083
CR111	211083	DIODE	SILICO		018		DANA	211083
CR114	211236	DIODE	SILICO		007		DANA	211236
CR115	211236	DIODE	SILICO		007		DANA	211236
CR118	220019	DIODE	SILICO	ZENER	1N752A		MOTOROLA	1N752A
CR119	220019	DIODE	SILICO	ZENER	1N752A		MOTOROLA	1N752A
CR120	211083	DIODE	SILICO		018		DANA	211083
CR121	211083	DIODE	SILICO		018		DANA	211083
C01	120007	CAP	MYLAR	.22 MFD	600 V	20%	ELEC CORP	210B1F224
C02	100091	CAP	PORCE	1 PFD	500 V		VITRAMON	VY10CA1R5CA
C03	110002	CAP	TANTA	22 MFD	35 V	10%	KEMET	K22C35K
C04	130136	CAP	VARI	6 PFD	250 V		S-T	10S-TR1K0-06
C05	100087	CAP	CERAM	4.7 PFD	100 V	5%	Erie	8101-A100-C0G-479J
C06	120011	CAP	POLYS	.068 MFD	100 V	10%	CDE	WMF1568
C07	110023	CAP	TANTA	2.2 MFD	35 V	10%	KEMET	K22C35K
C08	130137	CAP		18 PFD	250 V		S-T	10S-TR1K0-06
C09	130137	CAP		18 PFD	250 V		S-T	10S-TR1K0-06
C10	100089	CAP	CERAM	4700 PFD	100 V	5%	ERIE	8141-17100-C0G-472J
C11	111262	CAP	ELECT	10 MFD	25 V	20%	SPRAGUE	TL1204
C12	110017	CAP	TANTA	1 MFD	35 V	10%	KEMET	K1C35K
C125	121088	CAP	MYLAR	.01 MFD	100 V	10%	CDE	WMF1S1
C126	120093	CAP	POLYS	470 PFD	500 V	5%	CRL	CPR-470J
C127	120153	CAP	POLYS	47 PFD	125 V	10%	MIAL	611
C13	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C14	110154	CAP	TANTA	68 MFD	3 V	10%		K68E6
C15	100012	CAP	CERAM	33 PFD	500 V	10%	AEROVOX	TCD-N750
C16	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C17	120270	CAP	MYLAR	.039 MFD	100 V	5%	IMB	XA2B393J

ASSEMBLY 403477 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION							
C18	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J	
C19	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J	
C20	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J	
C21	120129	CAP	MYLAR	1.5 MFD	100 V	5%	IMB	XT2B155J	
C22	120270	CAP	MYLAR	.039 MFD	100 V	5%	IMB	XA2B393J	
C23	121468	CAP	MYLAR	.022 MFD	100 V	10%	CDE	WMF1S22	
C24	121093	CAP	MYLAR	.047 MFD	100 V	10%	CDE	WMF1S47	
C25	130138	CAP		4.5 PFD			ERIE	561-013	
C26	100087	CAP	CERAM	4.7 PFD	100 V	5%	ERIE	8101-A100-C0G-479J	
C28	100088	CAP		220 PFD	100 V	5%	ERIE	8121-M100-COG-221J	
C29	100090	CAP					ERIE TECH		
C30	100050	CAP					SPRAGUE	10TCC-V22	
C31	100006	CAP	CERAM	10 PFD	500 V	10%	AEROVOX	TCD-N750	
C32	100006	CAP	CERAM	10 PFD	500 V	10%	AEROVOX	TCD-N750	
C33	100023	CAP		.01 MFD	TYPE TTP		AEROVOX	100V	
C34	110151	CAP		10 MFD	25 V		ITT	43212-16210	
C35	100023	CAP		.1 MFD			ERIE	5815-000Y5U104Z	
J18	600326	CONN					WINCHESTER	JP3P-1S-AC	
K01	310035	RELAY	REED	SPST	24V		AZTEC	LIA24-S1	
K02	310035	RELAY	REED	SPST	24V		AZTEC	LIA24-S1	
C36	100017	CAP	CERAM	.01 MFD		20%	SPRAGUE	TG-S10	
K03	310036	RELAY	REED				ELEC-TROL	R2096-3	
K107	310036	RELAY	REED				ELEC-TROL	R2096-3	
K109	310036	RELAY	REED				ELEC-TROL	R2096-3	
K110	310036	RELAY	REED				ELEC-TROL	R2096-3	
M02	230070	INTEGRATED CIRCUIT		UA725			FAIRCHILD	U5B7725393	
M101	230103	INTEGRATED CIRCUIT					NATIONAL	LM308	
P17	600069	CONN	15 P				CINCH	2311512121	
Q01	200107	TRANS	N-CHAN FIELD EFFECT				FAIRCHILD	2N4302	
Q02	200163	TRANS					FAIRCHILD	2N916	
Q03	200040	TRANS	SILICO NPN	016			DANA	200040	
Q04	200040	TRANS	SILICO NPN	016			DANA	200040	
Q05	200095	TRANS					FAIRCHILD	2N3563 (See 200093)	
Q06	200095	TRANS					FAIRCHILD	2N3563 (See 200093)	
Q07	200095	TRANS					FAIRCHILD	2N3563 (See 200093)	
Q08	200099	TRANS					TI	2N4258	
Q09	200099	TRANS					TI	2N4258	

PARTS LIST

ASSEMBLY 403477 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION							
Q10	200095	TRANS						FAIRCHILD	2N3563 (see 200093)
Q106	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
Q107	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
Q108	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
Q109	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
Q110	200043	TRANS	SILICO	NPN	2N3565			FAIRCHILD	2N3565
Q119	200140	TRANS	DUAL	TYPE	140 NPN			DANA	200140
R01	000683	RES	CARBON	68 K	5%	1/4 W		OHMITE	RC07GF683J
R02	010746	RES	SET					DANA	010746
R03	010746	RES	SET					DANA	010746
R04	040115	RES	VARI	500 K	10%			BECKMAN	62PR500
R05	000473	RES	CARBON	47 K	5%	1/4 W		OHMITE	RC07GF473J
R06	000823	RES	CARBON	82 K	5%	1/4 W		OHMITE	RC07GF823J
R07	010746	RES	SET					DANA	010746
R08	040114	RES	VARI	50 K	10%			BECKMAN	62PR50
R09	000302	RES	CARBON	3 K	5%	1/4 W		OHMITE	RC07GF302J
R10	000333	RES	CARBON	33 K	5%	1/4 W		OHMITE	RC07GF333J
R11	000363	RES	CARBON	36 K	5%	1/4 W		OHMITE	RC07GF363J
R115	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R12	010746	RES	SET					DANA	010746
R120	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R125	010073	RES	METAL	51.1 K	1%			IRC	RN60D
R126	040067	RES	VARI	200 K	10%	1/4 W		BECKMAN	62PR200K
R127	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R128	020624	RES		1.02 K	0.1%			JORDAN	J11
R129	020625	RES		100.91 K	0.05%			JORDAN	J11
R13	040183	POT		10 OHM				BECKMAN	62PR10
R130	020626	RES		9 K	0.05%			JORDAN	J11
R131	040122	RES	VARI	200 OHM				BECKMAN	62PR200
R132	000102	RES	CARBON	1 K	5%	1/4 W		OHMITE	RC07GF102J
R136	040097	RES	VARI	5 K	10%			BECKMAN	62PR5K
R138	010465	RES	METAL	1.106 MEG	.1%			PYROFILM	PME65-T9
R14	001788	RES	CARBON	470 OHM	5%	1 W			
R142	040046	RES	VARI	20 K	10%	1/4 W		BECKMAN	62PR20K
R143	600245	JUMPER						GETTIG	L-2007-1

PARTS LIST

ASSEMBLY 403477 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION							
R144	010466	RES	METAL	9.950	MEG	.1%	1 W	PYROFILM	PME70
R15	010746	RES	SET					DANA	010746
R162	020609	RES	WW	20	K	1%		C-F	M-30
R167	040207	POT		200	K			IRC	750-10-200K
R168	600245	JUMPER						GETTIG	L-2007-1
R169	010476	RES	METAL	10	MEG	1%	1/2 W	PYROFILM	PME70-T2
R17	000302	RES	CARBON	3	K	5%	1/4 W	OHMITE	RC07GF302J
R170	600245	JUMPER						GETTIG	L-2007-1
R171	010476	RES	METAL	10	MEG	1%	1/2 W	PYROFILM	PME70-T2
R172	000515	RES	CARBON	5.1	M	5%	1/4 W	OHMITE	RC07GF515J
R178	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R179	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R18	000133	RES	CARBON	13	K	5%	1/4 W	OHMITE	RC07GF133J
R180	000102	RES	CARBON	1	K	5%	1/4 W	OHMITE	RC07GF102J
R181	000202	RES	CARBON	2	K	5%	1/4 W	OHMITE	RC07GF202J
R182	000302	RES	CARBON	3	K	5%	1/4 W	OHMITE	RC07GF302J
R19	000433	RES	CARBON	43	K	5%	1/4 W	OHMITE	RC07GF433J
R20	000133	RES	CARBON	13	K	5%	1/4 W	OHMITE	RC07GF133J
R21	000512	RES	CARBON	5.1	K	5%	1/4 W	OHMITE	RC07GF512J
R22	000433	RES	CARBON	43	K	5%	1/4 W	OHMITE	RC07GF433J
R23	000223	RES	CARBON	22	K	5%	1/4 W	OHMITE	RC07GF223J
R24	000243	RES	CARBON	24	K	5%	1/4 W	OHMITE	RC07GF243J
R25	000512	RES	CARBON	5.1	K	5%	1/4 W	OHMITE	RC07GF512J
R26	000512	RES	CARBON	5.1	K	5%	1/4 W	OHMITE	RC07GF512J
R27	000822	RES	CARBON	8.2	K	5%	1/4 W	OHMITE	RC07GF822J
R28	000431	RES	CARBON	430	OHM	5%	1/4 W	OHMITE	RC07GF431J
R29	000243	RES	CARBON	24	K	5%	1/4 W	OHMITE	RC07GF243J
R30	000101	RES	CARBON	100	OHM	5%	1/4 W	OHMITE	RC07GF101J
R31	000103	RES	CARBON	10	K	5%	1/4 W	OHMITE	RC07GF103J
R32	000562	RES	CARBON	5.6	K	5%	1/4 W	OHMITE	RC07GF562J
R33	000562	RES	CARBON	5.6	K	5%	1/4 W	OHMITE	RC07GF562J
R34	000301	RES	CARBON	300	OHM	5%	1/4 W	OHMITE	RC07GF301J
R35	000621	RES	CARBON	620	OHM	5%	1/4 W	OHMITE	RC07GF621J
R36	000302	RES	CARBON	3	K	5%	1/4 W	OHMITE	RC07GF302J
R37	000302	RES	CARBON	3	K	5%	1/4 W	OHMITE	RC07GF302J
R38	010742	RES	METAL	SET				DANA	010742

ASSEMBLY 403477 - Model 700/703 A

REF. DESIG.	PART NO.	DESCRIPTION							
R39	010742	RES	METAL	SET				DANA	010742
R40	010742	RES	METAL	SET				DANA	010742
R41	010745	RES	METAL	SET				DANA	010745
R42	040206	POT						IRC	750-10-20K
R43	010744	RES	METAL	SET				DANA	010744
R44	010744	RES	METAL	SET				DANA	010744
R45	010744	RES	METAL	SET				DANA	010744
R46	010744	RES	METAL	SET				DANA	010744
R47	010743	RES	METAL	SET				DANA	010743
R48	010743	RES	METAL	SET				DANA	010743
R49	010745	RES	METAL	SET				DANA	010745
R50	000100	RES	CARBON	10	OHM	5%	1/4 W	OHMITE	RC07GF100J
R51	000390	RES	CARBON	39	OHM	5%	1/4 W	OHMITE	RC07GF390J
R52	040123	RES	VARI	1	K			BECKMAN	62PR1K
R53	020632	RES	WW	54.9	K	.1%		JORDAN	J-90
R54	000511	RES	CARBON	510	OHM	5%	1/4 W	OHMITE	RC07GF511J
R55	000511	RES	CARBON	510	OHM	5%	1/4 W	OHMITE	RC07GF511J
R56	000433	RES	CARBON	43	K	5%	1/4 W	OHMITE	RC07GF433J
R57	040088	RES	VARI	100	K	10%		BECKMAN	62PR100K
R58	000105	RES	CARBON	1	M	5%	1/4 W	OHMITE	RC07GF105J
R59	000202	RES	CARBON	2	K	5%	1/4 W	OHMITE	RC07GF202J

PARTS LIST

ASSEMBLY 403482 – Model 700/703

REF DES	PART NO.	DESCRIPTION					
C01	110127	CAP	TANTA	22 MFD	6.3 V	ITT	43212 12222
CR01	211083	DIODE	SILICO	018		DANA	211083
CR02	211083	DIODE	SILICO	018		DANA	211083
CR03	211083	DIODE	SILICO	018		DANA	211083
M01	230064	INTEGRATED CIRCUIT				TI	SN7404N
M02	230029	INTEGRATED CIRCUIT				TI	SN7401N
M03	230029	INTEGRATED CIRCUIT				TI	SN7401N
M05	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M06	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M07	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M08	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M09	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M10	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M11	230102	INTEGRATED CIRCUIT				MONSANTO	MCT2
M12	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M13	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M14	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M15	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M16	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M17	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
M18	230106	INTEGRATED CIRCUIT				MOTOROLA	MC9814P
Q01	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q02	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q03	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q04	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q05	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q06	200200	TRANS		NPN			
Q07	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q08	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q09	200043	TRANS	SILICO	NPN	2N3565	FAIRCHILD	2N3565
Q10	200043	TRANS	SILICO	NPN	2N3565	FAIRCHILD	2N3565
Q11	200043	TRANS	SILICO	NPN	2N3565	FAIRCHILD	2N3565
Q12	200200	TRANS		NPN			
Q13	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q14	200037	TRANS	SILICO	NPN	2N3646	FAIRCHILD	2N3646
Q15	200200	TRANS		NPN			

PARTS LIST

ASSEMBLY 403482 – Model 700/703

REF DES	PART NO.	DESCRIPTION					
R01	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R02	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R03	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R04	000100	RES	CARBON	10 OHM	5% 1/4W	OHMITE	RC07GF100J
R05	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R06	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R07	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R08	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R09	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R10	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R11	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R12	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R13	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R14	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R15	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R16	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R17	000331	RES	CARBON	330 OHM	5% 1/4W	OHMITE	RC07GF331J
R18	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R19	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R20	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R21	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R22	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R23	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R24	000472	RES	CARBON	4.7 K	5% 1/4W	OHMITE	RC07GF472J
R25	000471	RES	CARBON	470 OHM	5% 1/4W	OHMITE	RC07GF471J
R26	000102	RES	CARBON	1 K	5% 1/4W	OHMITE	RC07GF102J
R27	000202	RES	CARBON	2 K	5% 1/4W	OHMITE	RC07GF202J
R28	000751	RES	CARBON	750 OHM	5% 1/4W	OHMITE	RC07GF751J
R29	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R30	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R31	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R32	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R33	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R34	000182	RES	CARBON	1.8 K	5% 1/4W	OHMITE	RC07GF182J
R35	000182	RES	CARBON	1.8 K	5% 1/4W	OHMITE	RC07GF182J

PARTS LIST

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REF DES	PART NO.	DESCRIPTION					
R36	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R37	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R38	000103	RES	CARBON	10 K	5% 1/4W	OHMITE	RC07GF103J
R39	000242	RES	CARBON	2.4 K	5% 1/4W	OHMITE	RC07GF242J
R40	000152	RES	CARBON	1.5 K	5% 1/4W	OHMITE	RC07GF152J
R41	000511	RES	CARBON	510 OHM	5% 1/4W	OHMITE	RC07GF511J

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